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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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THE INSTITUTION OF ELECTRICAL ENGINEERS

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THE AMERICAN
INSTITUTE OF ELECTRICAL ENGINEERS

ABSTRACTS 1327–2136

VOLUME 56 **MARCH 1953** NUMBER 663

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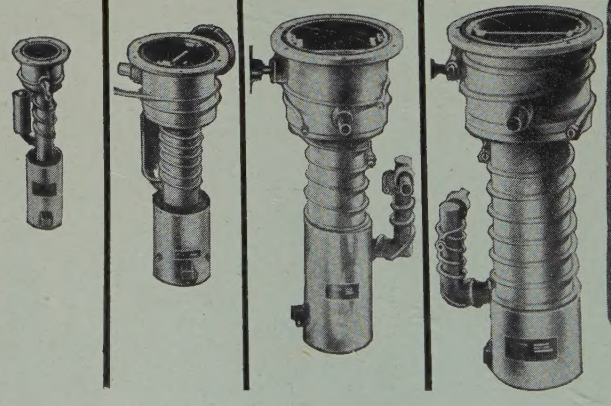

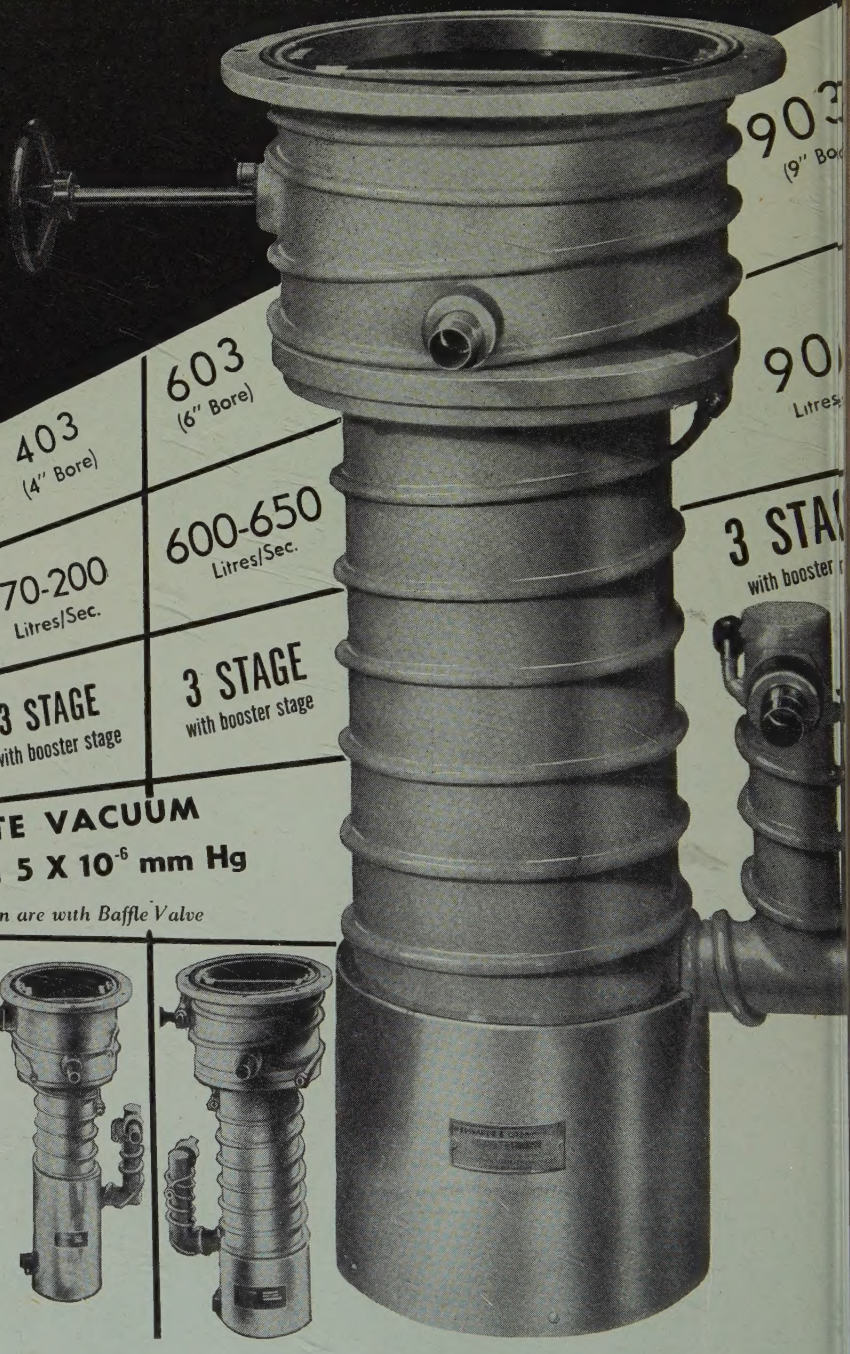

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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953). Reprints of the List of Journals can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Acta chem. Scand.	*Acta Chemica Scandinavica.* Ejnar Munksgaard, Nörregade 6, Copenhagen.
Aeronaut. Res. Coun. (Min. of Supply) Rep. Mem.	*Aeronautical Research Council (Ministry of Supply) Reports and Memoranda.* Her Majesty's Stationery Office, Kingsway, London, W.C.2.
Brit. Kinematogr.	*British Kinematography.* [Abstracted by *Photographic Abstracts.*]
Bull. Electrotech. Lab. [Tokyo]	*Bulletin of the Electrotechnical Laboratory.* Agency of Industrial Science and Technology, Ministry of International Trade and Industry, 2-chome, Nagato-cho, Chiyoda-ku, Tokyo.
Elektrowärme-Tech.	*Elektrowärme-Technik.* Elektro-Verlag W. Sachon K.G., 13b Mindelheim, Schloss Mindelburg, Germany.
Energetyka	*Energetyka.* Ul Stawowa 19, Katowice, Poland.
Org. Météorol. Internat. Publ.	*Organisation Météorologique Internationale. Publication.* World Meteorological Organization [Organisation Météorologique Mondiale], *formerly* International Meteorological Organization. 1 Avenue de la Paix, Geneva.
Researches Electrotech. Lab. [Tokyo]	*Researches of the Electrotechnical Laboratory.* Agency of Industrial Science and Technology, Ministry of International Trade and Industry, 2-chome, Nagato-cho, Chiyoda-ku, Tokyo.
Röntgenblätt.	*Röntgenblätter.* [Abstracted by *Photographic Abstracts.*]
Sci. Industr. Photogr.	*Sciences et Industrie Photographiques.* 165 Rue de Sèvres; 3 and 5 Boulevard Pasteur, Paris (XV^e).
Wire & Wire Prod.	*Wire and Wire Products.* [Abstracted by Metropolitan-Vickers.]

New Journals

Elect. Commun. Lab. Tech. J. [Tokyo]	*Electrical Communication Laboratory Technical Journal.* Electrical Communication Laboratory, Ministry of Telecommunications, 1551 Kichijoji, Musashino-shi, Tokyo. Vol. 1, No. 1 dated January, 1952. Quarterly.
Mem. Fac. Engng Nagoya Univ.	*Memoirs of the Faculty of Engineering of Nagoya University.* Faculty of Engineering, University of Nagoya, Mutsuno-cho, Atsuta-ku, Nagoya, Japan. Vol. 1, No. 1 dated April, 1949.
Sci. Pap. Coll. Gen. Educ. Univ. Tokyo	*Scientific Papers of the College of General Education. University of Tokyo.* College of General Education (Kyoyo-Gakubu), University of Tokyo, Komaba, Meguro-ku, Tokyo. Vol. 1, No. 1 dated October, 1951.

Notes

A.T.E. J.	*A.T.E. Journal*—formerly *Strowger Journal.* Title changed as from issue of *January*, 1953.
J. Soc. Glass Technol.	*Journal of the Society of Glass Technology.* "Thornton," Hallam Gate Road, Sheffield 10. Address changed as from February, 1953.

Errata

Abstr. 1020 (1952), line 4: *for* higher *read* lower.

Abstr. 1807 (1952), penultimate line: for j read γ.
last line: *add at end* if H is measured in amp/cm.

Abstr. 6525 (1952), last line: *add after* (1952): but replace *higher* in line 4 by *lower.*

Abstr. 9076 (1952), line 2: *for* R. H. LOVEBERG *read* R. H. LOVBERG.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 5761 (1952): **23**, 1413 (*Dec.*, 1952).

Abstr. 5917 (1952): **23**, 1413 (*Dec.*, 1952).

Abstr. 379 (1953): **21**, 189 (*Jan.*, 1953).

MATHEMATICS 51

517.6

1327. Integral variants associated with linear hyperbolic equations. F. H. VAN DEN DUNGEN. *C.R. Acad. Sci.* [*Paris*] **235,** 1106–7 (*Nov.* 10, 1952) *In French.*

An infinity of integral variants of a hyperbolic differential equation may be obtained from a moment generating function which satisfies a further differential equation. This result is illustrated for the linearized one-dimensional flow of an incompressible fluid. See also Abstr. 2 (1953). R. H. DALITZ

517.93 : 518.61

1328. On the numerical and graphical integration of oscillation equations. S. FLÜGGE. *Z. Phys.*, **133,** *No.* 4, 449–50 (1952) *In German.*

Solutions of the equation $d^2y/dx^2 + f^2(x)y = 0$ are expressed in the form $A_n \sin f_n(x - x_n) + B_n \cos f_n(x - x_n)$ for $x_n < x < x_n + 1$, and the solution over the required range in x is constructed from formulae of the form $y_{n+1} = y_n \cos(f_n \Delta x_n) + (y_n'/f_n) \sin(f_n \Delta x_n)$, $\Delta x_n = x_{n+1} - x_n$. A graphical interpretation of the procedure is given. R. A. NEWING

517.948

1329. The passage from the perturbation equations to integral equations. M. FABRE DE LA RIPELLE. *C.R. Acad. Sci.* [*Paris*] **235,** 1482–4 (*Dec.* 10, 1952) *In French.*

For a perturbation H to the Hamiltonian H_0, an integral equation is found for $\psi(r, s)$ [Fourier transform of $\psi(r, t)$], the kernel being an appropriate solution of H_0. R. H. DALITZ

518.1 : 53

1330. On the rôle of symmetrical domains in the calculation of certain physical quantities. G. POLYA. *C.R. Acad. Sci.* [*Paris*] **235,** 1079–81 (*Nov.* 10, 1952).

Three theorems are stated giving inequalities involving such quantities as rigidity of a bar, moment of inertia of a bar and electrostatic capacitance. Applications are given to geometrically simple cases. A. V. BREHME

518.43

1331. A graphical method for the integration of the Schrödinger equation. D. WISKOTT. *Z. Phys.*, **133,** *No.* 4, 443–8 (1952) *In German.*

Describes a geometrical procedure involving circle constructions and leading relatively quickly to a useful picture of the solutions to the Schrödinger equation for positive energy. R. H. DALITZ

518.5

1332. Programming a digital computer to learn. A. G. OETTINGER. *Phil. Mag.*, **43,** 1243–63 (*Dec.*, 1952).

Techniques for programming a digital computer to perform simple learning tasks are discussed with reference to two concrete examples. These examples have a particular bearing on questions proposed by Turing (1950) and by Wilkes (1951). By the application of the techniques described, digital computers can be made to serve as models in the study of the functions and of the structures of animal nervous systems. A.

518.5 : 621.5: 621.317.79

1333. Analog computers for coordinate transformation. N. L. FRITZ. *Rev. sci. Instrum.*, **23,** 667–71 (*Dec.*, 1952).

Problems in multicomponent analysis frequently require repetitive solutions of a set of simultaneous equations in which the coefficient terms do not change. In these cases it is advantageous to obtain a general solution from which the specific solutions may be obtained readily with simple instruments. An instrument is described which will solve a three-equation set as rapidly as an operator can set the values on the input dials and will simultaneously present the three answers with an accuracy of better than 0·2% of maximum value. A method is presented for calculating the accuracy of computation for use in the design of instruments of this type. A.

519.2 : 621.391

1334. On the theory of continuous information. H. ITÔ. *Proc. Japan Acad.*, **28,** 187–91 (*April*, 1952).

Indicates how the difficulty of defining the entropy of a continuous message system may be overcome by considering time and bandwidth together. E. H. SONDHEIMER

ASTRONOMY . ASTROPHYSICS . GEODESY 52

521.133

1335. A collision path from the Earth to the Moon in the restricted problem of three bodies. A. A. GOLDSTEIN AND C.-E. FRÖBERG. *K. Fysiogr. Sällsk. Lund. Förhandl.*, **22,** *No.* 14, 3 *pp.* (1952).

The trajectory of a projectile is computed for an initial speed of about 1·5× the escape velocity. The orbit of the moon relative to the earth is assumed to be circular. R. A. NEWING

523.11

1336. Gravitational instability of a turbulent medium. E. N. PARKER. Letter in *Nature* [*London*] **170,** 1030 (*Dec.* 13, 1952).

Chandrasekhar's formula for the critical wavelength [Abstr. 1392 (1952)] is derived from simple physical arguments involving the introduction of a "turbulence temperature." It is suggested that in applications of the formula, the speed of sound should be calculated

for a polytropic rather than for an adiabatic law of temperature variation on account of slow changes in density. R. A. NEWING

523.165

1337. Apparent angular sizes of discrete radio sources. *Nature* [*London*] **170,** 1061–5 (*Dec.* 20, 1952). **Observations at Jodrell Bank, Manchester.** R. H. BROWN, R. C. JENNISON AND M. K. DAS GUPTA [1061–3]. **Observations at Sydney.** B. Y. MILLS [1063–4]. **Observations at Cambridge.** F. G. SMITH [1064–5].

Measurements of the angular diameters of the radio-stars in Cygnus, Cassiopeia, Taurus, Virgo and Centaurus have been made with interferometric equipment of high resolving power and long base-line, at Manchester, Cambridge and Sydney, on frequencies of 125, 71 and 100 Mc/s respectively, the base-line varying from 0·3 to 10 km. The first-named object was observed at all three stations, and the second at Manchester and Cambridge. The results agree in suggesting for these two sources probable apparent diameters of $\sim 2'$ and $5'$ of arc, the Cygnus object being markedly asymmetric. These values are $>10^3$ times those found for the visible stars, and agree closely with the dimensions assigned by Baade and Minkowski to the nebulae in Cygnus and Cassiopeia identified recently with the two radio-sources. The objects in Taurus, Virgo and Centaurus have been found also to correspond to the positions of known nebulae; and it is now shown that their angular sizes are comparable with the nebulae in question. It appears highly probable, therefore, that the discrete radio-sources so far observed are largely, if not entirely, either galactic, or extra-galactic nebulae.

D. R. BARBER

523.2

1338. The cosmogony of the solar system. A. DAUVILLIER. *C.R. Acad. Sci.* [*Paris*] **235,** 1081–4 (*Nov.* 10, 1952) *In French.*

As opposed to the accretion theory of planetary evolution, the hypothesis of individual and successive fission from the parent body of pairs of planets, linked with the concept of subsequent fractionated thermal evaporation, is able to account for most of the observational facts including satellites as small as Mimas [see also Abstr. 725 (1952)]. D. R. BARBER

523.34 : 525.22

The [optical] polarization curve for the earth, and the nature of the lunar surface. *See Abstr.* 1352

523.42

1339. Determination of horizontal refraction in the atmosphere of Venus from the observation of the Lomonosov effect. V. V. SHARONOV. *Dokl. Akad. Nauk SSSR,* **82,** *No.* 3, 351–3 (1952) *In Russian.*

523.51 : 537.591.8

1340. Meteorites and cosmic rays. S. F. SINGER; Comment by F. A. PANETH. *Nature* [*London*] **170,** 728–9 (*Nov.* 1, 1952).

The problem of He production by cosmic rays is re-examined, consideration of the effects of cosmic-ray secondaries leading to a lower limit for the rate of He production by cosmic rays of $(5 \pm 1{\cdot}5) \times 10^{-14}$ cm^3/g/year at N.T.P. The relative contributions of cosmic radiation and radioactivity to meteorite He content can be estimated from the He^3/He^4 ratio, since radiogenic He is entirely He^4, while about 30% of that due to cosmic radiation finishes up as He^3. Observations of this ratio in agreement with these predictions are reported. By subtracting the cosmic-ray He, the "ages" of meteorites as determined by the usual U, Th, He method may be corrected. Other applications of these calculations are suggested: (i) the use of meteorites as integrating cosmic-ray meters; (ii) determination of the time of exposure of the meteorite to cosmic rays; and (iii) of the physical processes undergone by the surface of the meteorite since its creation, in particular its mass loss during its traversal of the atmosphere. M. W. OVENDEN

523.752

1341. A study of cine-films of the solar chromosphere at the border of the disk. M. DIZER. *C.R. Acad. Sci.* [*Paris*] **235,** 1016–18 (*Nov.* 3, 1952) *In French.*

The movements of solar "spicules" (first described by Secchi, 1875) has been studied from films of chromospheric activity near the solar limb. Their mean velocity of ascent and descent is 20 km/sec. They seldom rise to altitudes >13 seconds of arc, and remain visible for *c.* 2 min only, the mean height being *c.* 7000 km. D. R. BARBER

523.752

1342. The cause of sudden disappearance of [solar] filaments. A. BRUZEK. *Z. Astrophys.,* **31,** *No.* 2, 99–110 (1952) *In German.*

An enquiry as to whether the formation of fresh spot-groups in their vicinity is the cause of the rapid dissolution of chromospheric filaments. It is noted that in 1950–51 *c.* 60% of sudden disappearances of filamentary structure could be traced to an increase of spot-activity in the surrounding area. D. R. BARBER

523.752

1343. The propagation of [solar] eruption-activity. A. BRUZEK. *Z. Astrophys.,* **31,** *No.* 2, 111–14 (1952) *In German.*

Spectrohelioscopic Hα observations indicate that filament activity in regions remote from the main area of chromospheric eruption is initiated by a disturbance whose outward velocity is *c.* 100 km/sec. D. R. BARBER

523.82

1344. Observations of colour temperature of stars. Volume II. [ROYAL OBSERVATORY, GREENWICH.] *London, Her Majesty's Stationery Office* (1952) iv + 115 *pp.*

This volume continues and concludes work carried out with the 30 in. and later with the 36 in. reflector. Both instruments carried a slitless reflecting spectrograph behind the main mirror, giving a dispersion of some 240 Å/mm at Hα and 50 Å/mm at Hγ. The spectrum from 3790 Å to 6563 Å measured 1·25 in. and was broadened artificially to a width of 0·02 in. The spectrum of a third magnitude star could be photographed in one minute. A full description is given of the procedure at the telescope and of the laboratory density and calibration scaling. An account is also given of the two separate determinations of the absolute colour temperature of a few stars using (*a*) an acetylene flame, and (*b*) a tungsten filament lamp, with a statement on the fair approach

to a black body distribution in early type spectra above 4200 Å. The differences in gradients determined by other workers when much shorter wavelengths are used, are discussed. The corrections due to differences of exposure times for faint and bright stars have been fully examined, discussed and applied, and the variations due to different batches of plates have also been investigated. A long discussion is then given of the comparison of the results of this work with (*a*) similar gradients secured elsewhere, (*b*) with spectral types, (*c*) with colours measured by other workers, and (*d*) with colour indices. In all these comparisons the effect of the wider wavelength ranges used by other workers is assessed and the probable errors of the results are deduced. The peculiarities of the reddened stars are also strongly brought out. The next part of the volume gives the details for each particular star and this is followed by the collected results of the whole 250 stars. The volume concludes with the table for conversion of ϕ, c^2/T and T.

E. C. MARTIN

523.821

1345. Investigations on colour indices. III. A differential method for the determination of colour indices with Schmidt mirrors. S. GÜNTHER. *Z. Astrophys.*, **31**, *No.* 2, 132–9 (1952) *In German.*

For Pt II, see Abstr. 8450 (1950).

523.821

1346. Investigations on colour indices. IV. The short-wave colour-brightness diagram of the Pleiades and Praesepe. S. GÜNTHER. *Z. Astrophys.*, **31**, *No.* 2, 140–64 (1952) *In German.*

523.841.37

1347. Relationship between period, mean spectral type and phase difference for the Cepheids. P. DUMÉZIL-CURIEN. *C.R. Acad. Sci.* [*Paris*] **235**, 1011–13 (*Nov.* 3, 1952) *In French.*

It is shown that the empirical connection between period and mean spectral type which holds for Cepheids is a particularization of a generalized theoretical relationship involving an additional parameter, viz. phase-difference between variations of luminosity and radius of the star. Failure to take account of this is, in part, a cause of the dispersion found from the observational data. D. R. BARBER

523.842

1348. The period-density law $P\sqrt{\rho}$ = constant for spectroscopic binaries. E. A. KREIKEN. *Z. Astrophys.*, **31**, *No.* 3, 256–72 (1952).

Evidence is given to show that the period of orbital revolution systematically depends on the mean density of the teneous components of a pair. The relation between the period and the mean density is expressed by $\log P = -0{\cdot}542 \log \rho_{min} - 0{\cdot}301 \pm 0{\cdot}147$. This result seems to suggest that the period of orbital revolution cannot be shorter than the (Roche) limit set to the period of axial rotation. The velocities of axial rotation of the components of binary systems are compared with those of the single stars. It is found that the components of binary systems rotate slower than the single stars of the same spectral type. From a study of the mass-density diagram of the spectroscopic binaries it appears that in those parts of the $\mathfrak{M}\rho$ diagram, which correspond to high rotational velocities, no binary stars occur. The possible relation of Cepheids and binaries is discussed.

A.

523.851

1349. On Schwarzschild's integral equation. R. KURTH. *Z. Astrophys.*, **31**, *No.* 2, 115–20 (1952) *In German.*

A discussion of the necessary conditions for a general solution of the formal equation. A procedure for the numerical computation is suggested.

D. R. BARBER

523.851

1350. The determination of density in the globular star clusters. R. KURTH. *Z. Astrophys.*, **31**, *No.* 2, 121–2 (1952) *In German.*

Based on Schwarzschild's equation (preceding abstract), statistical expressions are derived for the surface, and spatial densities of a globular cluster.

D. R. BARBER

523.877

1351. Temporal evolution of a rotating mass of gas. S. VON HOERNER. *Z. Astrophys.*, **31**, *No.* 2, 165–74 (1952) *In German.*

Use is made of Wyse and Mayall's method (1942) to obtain an approximate solution of the hydrodynamical problem involving effects of frictional drag on the rotation of a toroidal mass of gas.

D. R. BARBER

525.22 : 523.34

1352. The [optical] polarization curve for the earth, and the nature of the lunar surface. A. DOLLFUS. *C.R. Acad. Sci.* [*Paris*] **235**, 1013–16 (*Nov.* 3, 1952) *In French.*

Observation of the degree of plane-polarization of the "earth-light" from the moon at early, and late phases, after proper correction for the depolarizing effect of diffuse reflection from the lunar surface, enables an estimate to be made of the degree of polarization of the light diffused into space by the sunlit earth. At 90° to the sun, polarization of this earth-light amounts to 36%, and it is verified that the observed albedo of the moon's disk is consistent with the suggestion made by Lyot (1929) that the lunar surface is covered with a layer of volcanic ash.

D. R. BARBER

525.61

1353. Free tidal oscillations in a rotating square sea. R. H. CORKAN AND A. T. DOODSON. *Proc. Roy. Soc. A*, **215**, 147–62 (*Nov.* 25, 1952).

Previous solutions have not been adequately illustrated numerically, and some have been limited to slow rotations. The use of iteration methods for a square sea indicated the possibility of covering a wider range of rotations and of exploring the use of such numerical methods in tidal problems where the interactions of tides in two phases offer unusual complications. In the case of a square sea these interactions only needed special consideration at the boundary. The investigation has been extended to throw light on the use of the energy equation to specify free oscillations, commonly referred to as Rayleigh's Principle, but adapted to rotating seas, and simpler solutions of well-known period formulae have been obtained. A.

526.3

1354. On the elimination of some errors of angular measurements. E. TERRANA. *R.C. Accad. Naz. Lincei*, **12**, 290–3 (*March*, 1952) *In Italian.*

526.76

1355. Concerning the precise determination of the acceleration due to gravity: the complex role of the viscosity of the gases. P. VERNOTTE. *C.R. Acad. Sci. [Paris]* **235**, 1110–11 (*Nov.* 10, 1952) *In French.*

The main obstacle to high precision in Volet's free fall method for g is the lack of knowledge of the law of resistance to non-uniform motion in a viscous medium. An attempt is made to derive such a law by dimensional analysis. In addition to the usual term for uniform motion an acceleration term is assumed and its form is derived. It is stated that the equation for the displacement of the falling body as a function of time t then contains a term in $t^{5/2}$ and another in t^3. The first can be eliminated by extrapolation to zero pressure and the second by the use of a second gas. S. WEINTROUB

PHYSICS 53

FUNDAMENTALS 530.1

530.12

1356. On the equations of the electromagnetic field in Einstein's most recent theory. M. PASTORI. *R.C. Accad. Naz. Lincei*, **12**, 302–7 (*March*, 1952) *In Italian.*

It is deduced from two of Einstein's conditions that the tensor conjugate to the antisymmetrical part of the fundamental tensor may be identified with the electromagnetic tensor. L. PINCHERLE

530.12

1357. Relativistic theory of a rigid body. R. W. DITCHBURN AND O. S. HEAVENS. Letter in *Nature [London]* **170**, 705 (*Oct.* 25, 1952).

On the basis of Gardner's theory [Abstr. 6271 (1952)] Synge has predicted an observable fringe shift when an interferometer, rigidly attached to the earth and with one arm inclined at 45° to the horizontal, is rotated about a vertical axis. Details of an experimental test of this prediction are given. No fringe shift was observed. R. A. NEWING

530.12

1358. Space, field, and ether in contemporary physics. A. W. STERN. *Science*, **116**, 493–5 (*Nov.* 7, 1952).

530.12

1359. Gravitation and electrodynamics. B. KURŞUNOGLU. *Phys. Rev.*, **88**, 1369–79 (*Dec.* 15, 1952).

In this paper Einstein's unified field theory is modified, and some of the physical implications of the new theory are examined. It entails: (1) a restriction of 4-current distribution, (2) an electromagnetic field consisting of short- and long-range parts, (3) a finite self-energy for the electron, (4) a classical description of pair production and annihilation as discussed by Feynman in his electrodynamics, (5) the Lorentz-force law for a charged particle moving in an external electromagnetic field, (6) the bending of light grazing the surface of the sun—the same as given by the general theory of relativity. A.

530.12

1360. The relativistic clock problem. F. I. MIKHAIL. *Proc. Cambridge Phil. Soc.*, **48**, *Pt IV*, 608–15 (1952).

The problem is treated purely by general relativity by considering a particular example in which the two observers are attached to two test-particles moving freely in the field of a gravitating mass; one of these makes complete revolutions in a circular orbit while the other moves radially outwards and inwards. The time-interval between two successive encounters is shorter in the reckoning of the former than in that of the latter. The difference is found to agree qualitatively with a naïve application of special relativity. A.

530.12

1361. The relativistically rigid rod. J. E. HOGARTH AND W. H. MCCREA. *Proc. Cambridge Phil. Soc.*, **48**, *Pt IV*, 616–24 (1952).

A relativistically rigid rod is defined as one along which any disturbance travels with the fundamental speed c without dissipation of energy. A necessary consequence of this definition is that the rod should satisfy a certain "equation of elasticity." If this equation is satisfied, it is shown in accordance with relativistic mechanics that a disturbance of any amplitude is propagated along the (unstressed or stressed) rod with speed c and without dissipation. Consequently, the equation provides also a sufficient condition for rigidity in the sense defined. A.

530.12

1362. Action as a co-ordinate of space. VI. YU. B. RUMER. *Zh. eksper. teor. Fiz.*, **22**, *No.* 6, 742–54 (1952) *In Russian.*

For Pt V, see Abstr. 5514 (1952). Real tensor fields in configuration 5-spaces of co-ordinates, time and action are considered which are periodical in the action co-ordinate. The first case considered is that of scalar mesons given by Lagrange functions and wave equation. The latter is represented by its Fourier components and the Fourier expansion introduced into the expressions of the canonic 5-tensor of energy-impulse and charge, this yielding the 4-tensor of energy-impulse and the 4-vector of the current. It is so found that the real scalar field W describes the whole family of scalar mesons of masses $|Z|m$ and charges Ze, where Z is a positive or negative integer excluding zero, i.e. the family may be regarded as a multiparticle in various discrete charge (mass) states. The existence of an external field may be allowed for by generally covariant formulation of the equations for a free particle, i.e. by the transition from an Euclidean to a Riemann 5-space. For scalar mesons 5-optics does not yield results beyond those known from Pauli–Weisskopf theory. Substantially new results are obtained for

vector mesons, the consideration of which is based on the Maxwell equations for the 5-space of configurations. The source-free vector field W_λ describes a family of vector mesons of Prok-type, provided the normalization of the potentials is Lorentz-invariant. $|Z|m$ are the masses, Ze the charges, where Z is any positive or negative integer, the case $Z = 0$ corresponding to classical electrodynamics. By Ginzburg's calibration of the potentials the field is divided into the photon (transverse wave) field and into the Coulomb interaction field of continuously distributed charges, where the interaction has Yukawa character. The last section considers the interrelation between Maxwell's electrodynamics and vector mesodynamics and shows how to combine them to a unified 5-dimensional Maxwell theory. The author's theory coincides with classical theory only in those cases in which an averaging of all quantities over the action co-ordinate is legitimate. In the general case the 5-dimensional theory contains in addition to the classical Coulomb energy of interaction terms corresponding to forces with progressively decreasing radii of action. If the problems involve interaction of charges over distances $\geqslant$ periods of the co-ordinate x^5, the classical ("averaged") theory may be applied, whereas at small distances the exact theory is required. B. F. KRAUS

530.12 : 531.18

1363. Velocity, qualitative magnitude and relativistic mechanics. J. ABELÉ. *C.R. Acad. Sci.* [*Paris*] **235,** 1007–9 (*Nov.* 3, 1952) *In French.*

Qualitative magnitudes are regarded as intermediate between simply ordered sets and measurable quantities. The states A, B, C of a system are associated with the real numbers, u, v, w, and the law of composition is such that, if C results from the superposition of A and B, there is a function F such that $F(w) = F(u) + F(v)$. Velocity is defined to be a qualitative magnitude where F is such that there exists a limiting velocity c. With uniform velocity as a fundamental concept, space-time and Lorentz transformations may be introduced without further assumptions. R. A. NEWING

530.12 : 531.18

1364. Investigation of an intrinsic law for the composition of velocities. P. MALVAUX. *C.R. Acad. Sci.* [*Paris*] **235,** 1009–11 (*Nov.* 3, 1952) *In French.*

Abelé's ideas (preceding abstract) are used to show that, for velocities in a fixed direction (with $c = 1$), $F(x) = \int_0^x (1 - x^2)^{-1} K(x)dx$, where $K(x)$ is an arbitrary even function of constant sign and such that $|F(x)| \to \infty$ when $x \to \pm 1$. The choice $K(x) \equiv 1$ gives the relativistic law, and the justification of this choice is discussed. R. A. NEWING

530.12 : 531.18

1365. Modified Newtonian systems. R. CAPILDEO. Letter in *Nature* [*London*] **170,** 936–7 (*Nov.* 29, 1952).

Transformation formulae of the Lorentz type are based on *ad hoc* postulates concerning the motion of light. Doppler effects and stellar aberration are discussed. R. A. NEWING

530.145 : 537.122

1366. On the nature of the mass and charge of electrons. H. SALECKER. Note in *Z. Naturforsch.*, **7a,** 633–4 (*Sept.*, 1952) *In German.*

Suggests that the bare mass m_0 and bare charge e_0 of the electron are zero, so that the observable mass and charge are divergence-free, the divergent integrals of the theory being multiplied by powers of e_0 and m_0. R. H. DALITZ

530.145 : 537.122

1367. On the electron *g*-factor according to classical field mechanics. L. WALDMANN. *Z. Naturforsch.*, **7a,** 645–8 (*Oct.*, 1952) *In German.*

For a constant e.m. field, there is an exact integral of the classical equations for the Honl pole-dipole particle, in which the relation between magnetic moment and angular momentum corresponds to the anomalous g-factor 2 for the electron. R. H. DALITZ

530.145 : 537.122

1368. The theory of the electron. III. W. WESSEL. *Z. Naturforsch.*, **7a,** 583–93 (*Sept.*, 1952) *In German.*

For Pt II, see Abstr. 1752 (1952). To remove a reality difficulty in the interpretation of the invariant K, the theory is modified by interchange of ι_k and $\mathcal{H}_k$. The mass operator proposed from classical considerations then leads to an electron magnetic moment additional to the Dirac moment. The infinite matrices in the unperturbed equation are avoided by using a finite (and not equivalent) representation of the commutator algebra and the Dirac equation then results, but with an anomalous moment 16/3 too large. R. H. DALITZ

530.145

1369. Analytical characterization of [physical] quantities in quantum mechanics. L. FANTAPPIÈ. *R.C. Accad. Naz. Lincei,* **12,** 285–90 (*March,* 1952) *In Italian.*

Emphasis is placed on the fact that physical variables must be observable, and "objective" in the sense of being capable of definition independently of particular observers. The restrictions imposed by these requirements upon representations in terms of linear operators are discussed. R. A. NEWING

530.145

1370. On the axiomatic foundation for quantum mechanics. P. JORDAN. *Z. Phys.*, **133,** *No.* 1–2, 21–9 (1952) *In German.*

Discusses the derivation of quantum mechanics from three postulates, in which the basic laws of quantum-mechanical measuring processes are expressed, without appeal to the correspondence analogy or to the concept of operators or matrices. The principle of reproducible measurement must probably be given up in a complete theory of the elementary length, the first steps of which are contained in the renormalization procedures. R. H. DALITZ

530.145

1371. The physical aspects of the wave-particle problem. L. JÁNOSSY. *Acta phys. Hungar.*, **1,** *No.* 4, 423–68 (1952).

The basic concepts of quantum theory are analysed. It is investigated in detail how far the results of

orthodox quantum theory follow by necessity from experimental findings. As the result of this analysis it is concluded that some of the speculative results of quantum theory can be dispensed with and that it should not be impossible, at least in principle, to find a model for quantum phenomena, the model being much closer to a classical one than it is usually believed possible. Such a model would dispense with the unacceptable idealistic conclusions of the theory without contradiction of those results of the theory which are directly established by experiment. The model explicitly uses the assumption of action propagated with over-light velocity; it is pointed out that a straightforward analysis of experimental facts leads necessarily to such an assumption. A.

530.145

1372. On the solutions of the equation of evolution. R. GUY. *C.R. Acad. Sci.* [*Paris*] **235,** 1194–6 (*Nov.* 17, 1952) *In French.*

The existence theorem obtained for solutions of an operator integral equation [Abstr. 8501 (1951)] is now established under less restrictive conditions.

R. A. NEWING

530.145

1373. Note on the connections between elementary particles. G. SZAMOSI. Note in *Acta phys. Hungar.*, **2,** *No.* 1, 85–7 (1952).

The Lagrangian of a field equation of higher than 2nd order is reduced to a Lagrangian corresponding to a number of fields satisfying 2nd-order equations.

R. H. DALITZ

530.145

1374. The measurement of quantum-mechanical operators. E. P. WIGNER. *Z. Phys.*, **133,** *No.* 1–2, 101–8 (1952) *In German.*

The usual assumption in quantum mechanics, that all Hermitian operators represent measurable quantities is generally recognized as a mathematical idealization. Here it is shown that, in fact, the validity of the conservation theorems for quantized quantities, which govern the interaction of measuring apparatus and object, allows the measurement of most operators only as a limiting case. In particular, the conditions for the measurement of operators which do not commute with both the total charge and the total number of heavy particles, are probably not satisfied. R. H. DALITZ

530.145

1375. On reversal of the motion in quantized field theory. G. LÜDERS. *Z. Phys.*, **133,** *No.* 3, 325–39 (1952) *In German.*

For the quantum electrodynamics of electrons the effect of time-reversal is explicitly formulated, and its invariance under time-reversal deduced; for an arbitrary field theory, time-reversal is axiomatically formulated. The requirement of invariance under time-reversal limits the couplings possible between fields: the lack of such invariance would not necessarily have thermodynamic consequences. R. H. DALITZ

530.145

1376. The relativistic configuration space formulation of the multi-electron problem. M. GÜNTHER. *Phys. Rev.*, **88,** 1411–21 (*Dec.* 15, 1952).

A relativistic configuration space (many-time) presentation of quantum electrodynamics is developed, which, being equivalent to the Tomonaga–Schwinger formalism, may be expected to have the advantage of its direct applicability to bound-state problems of multi-electron systems. The main purpose of this paper is therefore to get an evidently relativistically invariant description of the interactions between individual electrons, in such a way, however, as to avoid those divergence difficulties which may be accounted for by the use of electron plane waves for building up the actual state of the system. The order of the presentation is as follows: a general relativistically invariant proof of equivalence of the Tomonaga–Schwinger formalism and the many-time formalism of Dirac, Fock and Podolski provides a necessary starting point for further generalization in the form of an equation, whose solution gives rise to a formal extension of the multi-electron wave function concept into regions for which the latter remained hitherto undefined. A method of elimination of virtual processes is outlined and invariant expressions for the multi-electron interactions are derived. All explicit derivations are carried out to terms of the order of e^2. An example, a relativistic two-electron wave equation, is given. This equation acounts for the Coulomb and Breit interactions. A.

530.145

1377. On the energy-momentum tensor of Maxwell–Minkowski electrodynamics. H. OTT. *Ann. Phys.* [*Leipzig*] **11,** *No.* 1, 33–44 (1952) *In German.*

The energy-flow and momentum components of Minkowski's tensor are made symmetric by the addition of a tensor, obtained from the standpoint of Lorentz electron theory. With this, the relation $\mathbf{S} = \mathbf{E} \times \mathbf{H} = c^2\mathbf{g}$, known to be valid for the vacuum, holds also for the Maxwell fields in matter.

R. H. DALITZ

530.145

1378. On a possibility for covariant generalization of the intermediate coupling theory.. I. M. JEAN. *C.R. Acad. Sci.* [*Paris*] **235,** 794–6 (*Oct.* 13, 1952) *In French.*

Proposes an equation which may serve as a basis for covariant generalization of the Tomonaga intermediate coupling theory and which, in a perturbation treatment, leads to the Feynman results for a free nucleon. R. H. DALITZ

530.145

1379. On a possibility for covariant generalization of the intermediate coupling theory. II. M. JEAN. *C.R. Acad. Sci.* [*Paris*] **235,** 1197–9 (*Nov.* 17, 1952) *In French.*

Examines the possibility of generalizing Tomonaga's method of approximation for the solution of the covariant equations proposed in Pt I. A variational principle and some possible trial functions are presented. R. H. DALITZ

530.145

1380. Bound states and the interaction representation. S. T. MA. Letter in *Phys. Rev.*, **88,** 1211 (*Dec.* 1, 1952).

An apparent inconsistency in the author's previous paper [Abstr. 8675 (1952)] is clarified, and its origin is illustrated by a particular example. R. H. DALITZ

530.145

1381. On the static interaction of leptons due to a de Broglie field. F. Cap. *Acta phys. Austriaca*, **6**, *No.* 1, 35–44 (1952) *In German.*

Calculates the static interaction energy between two spin-½ leptons due to their mutual coupling with a de Broglie field describing photons of finite rest-mass. R. H. DALITZ

530.145

1382. Fermion types and ensuing selection rules. E. R. Caianiello. *Nuovo Cimento*, **9**, 336–50 (*April*, 1952) *In Italian.*

Inconsistencies of previous treatments are eliminated and a criterion is proposed to determine the types allowed under a given inversion. It is shown that, if one accepts the hypothesis that a universal Fermi-type interaction exists, the conditions which this hypothesis sets on the fermion types permit, together with the information deriving from the known interactions of fermions with bosons, a fairly definite determination of the fermion types. Many new selection rules follow which are effective in processes in which fermions change their nature. The establishment of an independent check on the possibility of a universal interaction is aimed at, at least so far as it is assumed to derive from simple requirements of relativistic invariance: it would have to be rejected if deductions should prove inconsistent with experiment. Alternatively, the information gathered from the knowledge of the fermion types would play in the study of elementary phenomena a role similar to that of bosons parities. The results obtained thus far seem to favour the second alternative. A.

530.145

1383. On the creation of pairs of particles in the collision processes between particles of spin $\hbar/2$. P. Havas. *J. Phys. Radium*, **13**, 438–40 (*Oct.*, 1952) *In French.*

Points out that some possible graphs are omitted in Petiau's discussion [Abstr. 3282 (1952)] of pair creation arising from the collision of two spin ½ particles and gives the corresponding matrix elements. R. H. DALITZ

530.145

1384. On the de Broglie theory of the photon. M. El-Nadi. *J. Phys. Radium*, **13**, 540–2 (*Nov.*, 1952) *In French.*

A notation especially suitable for the de Broglie theory of spin-1 particles is proposed, which clarifies the correspondence between the real macroscopic fields and the imaginary microscopic fields associated with a photon in this theory. R. H. DALITZ

530.145

1385. Spinor formulation of beta-decay and similar interactions. M. H. L. Pryce. *Z. Phys.*, **133**, *No.* 1–2, 309–18 (1952).

The possible forms for the interaction energy involving four spin ½ particles are written in spinor notation, their behaviour under space and time inversions discussed (assuming $\psi \rightarrow \pm \psi$ after two inversions) and their relation with the usual invariants explicitly stated. With this notation, known relations are obtained concerning the permutation properties of these possible forms and the interactions with special symmetry. R. H. DALITZ

530.145

1386. The quantization of classical spin theory. S. Shanmugadhasan. *Canad. J. Phys.*, **31**, 1–10 (*Jan.*, 1953).

The antisymmetric spin tensor of rank two used to describe the rotational motion of a particle is assumed to satisfy the constraint condition that the velocity 4-vector is orthogonal to it. Since the dipole moment is proportional to the spin tensor, this condition leads always to a purely magnetic dipole in the rest system of the particle. Frenkel has indicated how the action principle for the classical equations of motion can be set up treating the above constraint condition as a supplementary condition. The Hamiltonian dynamics of a system having supplementary conditions and Lagrange undetermined multipliers has been discussed recently by Dirac. Dirac's method and results previously obtained give the required Hamilton–Jacobi equations and Poisson Brackets of the dynamical variables. The cases where the particle behaves like a pure gyroscope and a symmetrical top are treated. When there is an interacting field, it is assumed that the action of the field is given by the effective 4-vector potential without further specification. The orthogonality of the velocity to the tensor dual to the spin tensor can be imposed as an alternative constraint condition. This possibility is discussed briefly. The quantum formulation is completed with the help of the standard analogy rules. A.

530.145

1387. On the equivalence of two definitions of the *S*-matrix. S. Fubini. *R.C. Accad. Naz. Lincei*, **12**, 298–302 (*March*, 1952) *In Italian.*

A mathematical proof is given of the equivalence of the definition by means of solutions of the time-independent Schrödinger equation and of that which considers the *S*-matrix as the unitary operator which, in the interaction representation, transforms the state of the system at $t = -\infty$ into that at $t = \infty$. L. PINCHERLE

530.145

1388. On a modified definition of Riesz potential for the meson case. L. S. Kothari. *Proc. Phys. Soc.* [*London*] *A*, **65**, 930–3 (*Nov.*, 1952).

A modified definition of the Riesz potential for the meson field is introduced. It is shown that the new definition is a generalization, in the α-plane, of the meson potential in the interaction representation. The relations satisfied by the meson potential in the interaction and in the Schrödinger representations are compared. A.

530.145

1389. Quantum field theory of bound states. I. Bound states in weak interaction. R. J. Eden. *Proc. Roy. Soc. A*, **215**, 133–46 (*Nov.* 6, 1952).

When compound particles as well as fundamental particles are involved in a collision two different mathematical techniques are required. These are (i) the scattering method as developed in the field theory of the *S*-matrix, and (ii) the bound-state method which corresponds to a selective summation

of infinite series of terms in the *S*-matrix. This correspondence is discussed and general conditions are obtained which must be satisfied by any bound-state method. Weak interaction assumptions are made which permit the complete separation of the bound-state method and the scattering method in a collision involving bound states. The separation is achieved by a modified interaction representation in which a constant-state vector may describe fundamental particles and one or more compound particles moving without mutual interaction. The calculation of the *S*-matrix between two states which are constant in this representation involves the propagation functions for compound particles. These propagators are discussed from two viewpoints, that of Bethe and Salpeter (1951), and a new method based on the modified interaction representation. These methods differ in the way in which infinite series of interactions are summed, though both satisfy the general conditions developed earlier in the paper. It is shown that, for the two-body problem in quantum electrodynamics, the new method leads to a propagator which contains a complex rest mass term. This is the relativistic analogue of the complex energy which Dirac (1947) has related to spontaneous emission. The method is illustrated by a simple example on resonance scattering. A.

530.145

1390. Lower limits for interaction times in photon scattering processes. E. GORA. Letter in *Phys. Rev.*, **88**, 1212–13 (*Dec.* 1, 1952).

Obtains a lower limit for the interaction time of processes for which the formulae of the quantum theory of radiation are essentially valid. For photon-electron scattering the result confirms a semi-classical argument. For photon-photon scattering the limit is $\sim 3 \times 10^{-15}$ sec. R. H. DALITZ

530.145

1391. An example of a divergent perturbation expansion in field theory. C. A. HURST. *Proc. Cambridge Phil. Soc.*, **48**, *Pt IV*, 625–39 (1952).

The convergence of the perturbation expansion for the *S*-matrix in interaction representation of a three-boson contact interaction is investigated. A lower bound is obtained for the integrals corresponding to irreducible graphs when the total rest mass of the system is insufficient for bare particles to be created. It is shown that in this case the perturbation expansion cannot converge no matter what value the coupling constant has. A discussion is given of the bearing of this result on the general problem of the convergence of perturbation expansions for the *S*-matrix in renormalized field theories. A.

530.145

1392. On the rôle of spin in the non-relativistic theory of the scattering of radiation. P. SVENONIUS AND I. WALLER. *Ark. Fys.*, **6**, *Paper* 2, 119–21 (1952).

The e.m. interaction arising from the spin of a non-relativistic electron is discussed and the matrix elements obtained are compared with those of other treatments. R. H. DALITZ

530.145

1393. Forces acting on the usual lines of flow for particles of spin 0, ½ and 1 in the pilot-wave theory. J.-P. VIGIER. *C.R. Acad. Sci.* [*Paris*] **235**, 1107–9 (*Nov.* 10, 1952) *In French.*

For the β-matrix theory of particles of spin 0 and 1, expressions for the forces are obtained, which allow passing over to the double solution interpretation of the unitary theory. R. H. DALITZ

530.145

1394. On the conservation of charge. A. RÉGNIER. *C.R. Acad. Sci.* [*Paris*] **235**, 1370–2 (*Dec.* 1, 1952) *In French.*

Assuming the usual expression for current density, all equations whose evolution with time is expressed by a semi-group of linear transformations and which imply the continuity equation, are shown included in the equations usually considered. R. H. DALITZ

530.145

1395. Wave mechanics in configuration space. J.-P. VIGIER. *C.R. Acad. Sci.* [*Paris*] **235**, 1372–5 (*Dec.* 1, 1952) *In French.*

Using the unitary theory [Abstr. 1393 (1953)] and Régnier's theorem (preceding abstract), a justification is given of the hypotheses introduced by de Broglie to demonstrate the validity of the Schrödinger equation for several particles in his new interpretation. R. H. DALITZ

530.145

1396. On the interpretation of the wave mechanics of systems of particles in configuration space, according to the double solution theory. L. DE BROGLIE. *C.R. Acad. Sci.* [*Paris*] **235**, 1345–9 (*Dec.* 1, 1952) *In French.*

Justifies, for the double-solution pilot-wave theory, the passage from the wave mechanics of a particle in a given field to that of systems of interacting particles, in configuration space. R. H. DALITZ

530.145

1397. The wave mechanics of systems of similar particles and the double solution theory. L. DE BROGLIE. *C.R. Acad. Sci.* [*Paris*] **235**, 1453–5 (*Dec.* 10, 1952) *In French.*

For a system of interacting particles, in double-solution theory, the fact that different singularities of the same wave are interchangeable must imply the symmetric or anti-symmetric character of the Ψ-wave in configuration space. R. H. DALITZ

530.145

1398. The passage of a wave packet through a potential barrier. L. JÁNOSSY. *Acta phys. Hungar.*, **2**, *No.* 2, 171–4 (1952).

It is shown that a one-dimensional wave packet colliding with an infinitely thin potential barrier splits as the result of the collision into two parts; analytic expressions for the fragments are given. A.

530.162 : 536.7

1399. Statistical mechanics of irreversibility. H. B. CALLEN, M. L. BARASCH AND J. L. JACKSON. *Phys. Rev.*, **88**, 1382–6 (*Dec.* 15, 1952).

The fluctuation-dissipation theorem relating spontaneous equilibrium fluctuations to the conductance in a dissipative thermodynamic system is extended to the case of several variables, using a quantum statistical analysis. The conductance matrix is shown

to be subject to certain symmetry relations, providing a generalization of the Onsager reciprocity theorem. The susceptance matrix is also shown to be subject to similar symmetries. The symmetries apply to all frequency components, and hence to arbitrary transient processes. A.

530.162 : 548.5

Statistical mechanics and the partition of numbers. II. The form of crystal surfaces. *See Abstr.* 2049

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.258

1400. Thermal stresses in a partially clamped elastic half-plane. J. H. HUTH. *J. appl. Phys.*, **23**, 1234–7 (*Nov.*, 1952).

Numerical methods, such as those of Southwell, have made amenable to approximate analysis a large class of problems in the theory of elasticity. However, certain loadings must occasionally be considered which may give rise to theoretical stress singularities. In such cases an analytical study, at least in the immediate neighbourhood of the singularities, would appear to be mandatory. One such problem is that of determining the thermal stresses in a partially clamped elastic half-plane. The solution given in this paper assumes self-equilibrating tractions over the clamped portion of boundary so that the results apply approximately also to large finite areas. A.

MECHANICAL MEASUREMENTS 531.7

531.715.1 : 535.417

The limit of accuracy in the measurement of the thickness of a thin film using the Köster's interference double prism. *See Abstr.* 1558

531.719.1 : 535.822.1

1401. Evaluation of small radii of curvature using the light-profile microscope. S. TOLANSKY AND M. OMAR. Letter in *Nature* [*London*] **170**, 758–9 (*Nov.* 1, 1952).

The light-profile microscope [Abstr. 4284 (1952)] is applied to the measurement of the radius of curvature of a small metal sphere, calibration being performed by means of Newton's rings with a 0·6 mm sphere. Accuracy of 1% is attainable. S. TOLANSKY

531.791

1402. A device for counting small particles suspended in a fluid through a tube. P. J. CROSLAND-TAYLOR. Letter in *Nature* [*London*] **171**, 37–8 (*Jan.* 3, 1953).

The apparatus is described and shown diagrammatically. A suspension of the particles is slowly injected through a 125 μ diameter tapered needle downwards into a faster stream of gas-free water which enters from the side into an observation chamber in a brass block. The particle stream is narrowed down as it approaches a vortex tube with platinum tip and 0·16 mm diameter hole. A negative pressure of 25 cm Hg is applied to the vortex. Dark-ground illumination is used. S. WEINTROUB

531.791 : 539.215.4

1403. Automatic method of granulometric analysis. L. LE BOUFFANT AND J.-L. SOULÉ. *C.R. Acad. Sci.* [*Paris*] **235**, 1207–10 (*Nov.* 17, 1952) *In French.*

The apparatus analyses a photo-micrograph of small particles by scanning with a light beam. The transmitted beam falls upon a photocell and actuates counting mechanisms set at different threshold values. The counters yield an analysis of the particles by area. R. W. FISH

MECHANICS OF FLUIDS 532

532.13 : 532.14 : 532.612.4

1404. Physical properties of liquid fluorine. G. W. ELVERUM, JR AND R. N. DOESCHER. *J. chem. Phys.*, **20**, 1834–7 (*Dec.*, 1952).

The viscosity, density and surface tension of liquid F and their dependence on temperature have been measured. The change in viscosity with temperature indicates that F behaves as a normal liquid in the region studied. The results of the measurement of the density confirm a new much larger value for this property than previously accepted. Measurements of the surface tension given in this paper are in substantial agreement with values reported earlier in the literature if these early values are adjusted by means of the density determinations made by the authors. A.

532.13 : 532.73

1405. Variation of the specific viscosity of a solution of rigid macromolecules with frequency. R. CERF. *J. Phys. Radium*, **13**, 458–64 (*Oct.*, 1952) *In French.*

A calculation of the complex viscosity under high frequency considering a rigid ellipsoid of revolution. For monodispersed solutions the viscosity is shown to be equal to the sum of the classical term and the Brownian term, this being equal to the classical term times a factor which is a function of the frequency. T. C. TOYE

532.13 : 536.22

1406. Viscosity and thermal conductivity of liquid argon. E. N. DA C. ANDRADE. Letter in *Nature* [*London*] **170**, 794 (*Nov.* 8, 1952).

In the light of his well-known theory of viscosity the author suggests that the formula $k/\eta = Bc_v$ should hold k = thermal conductivity, η = viscosity, and c_v = specific heat at constant volume (all at the m.pt.) while B is a constant which should be about 1. Tests on liquid A give a value of B very close to this figure. T. C. TOYE

532.51

1407. Radial flow of a compressible viscous fluid between two parallel planes. R. COMOLET. *C.R. Acad. Sci.* [*Paris*] **235**, 1190–3 (*Nov.* 17, 1952) *In French.*

A solution of the usual equations of motion, expressed in polar cylindrical co-ordinates, is obtained

in the case of a viscous, compressible gas obeying the ordinary equation of state $p/\rho = rT$. The flow is considered to possess symmetry of revolution about a vertical axis. An approximate solution is derived for the case when inertial forces are negligible compared with viscous forces, and an expression is derived for the mass flow of fluid between the plates. The expression $M = \pi d^3 P_1(P_0 - P_1)/6\,\mu\,RT_0$ derived for the mass flow for the case in which the pressure drop, $P_0 - P_1$, is small, under the assumption that pressure p and density ρ of the fluid obey the relation $p/\rho^n = \text{const.}$, agrees, so far as its proportionality to the pressure drop $P_0 - P_1$ is concerned, with the expression found for an incompressible fluid. When $P_0 - P_1$ is large the effects of compressibility are large, velocity components and exchange of heat with the walls become important and the adiabatic law of state ($n = \gamma$) must be taken into account.

J. S. G. THOMAS

532.51

1408. Note on discrepancies between two theories on the stability of plane Poiseuille flow. T. TATSUMI. *J. Phys. Soc. Japan*, **7**, 619–24 (*Nov.–Dec.*, 1952).

Existing theories of the hydrodynamical stability of plane Poiseuille flow are divided into two groups by their quite different conclusions. Results attained by Lin and other earlier authors are that this flow is unstable for sufficiently large Reynolds numbers. On the other hand, Pekeris has obtained the different result that the flow is stable for any value of the Reynolds number and that, in addition to the ordinary disturbances discussed by earlier authors, there exists another class of perturbation which is characterized by $c_r \to 1$ as $\alpha R \to \infty$. A critical survey for these conflicting results is presented. It is shown that Pekeris's first result arises essentially from the poor convergency of his series expansion of c, namely $c = c_0 + \alpha^2 c_1 + \ldots$, and that if this procedure is avoided, the existence of Lin's stability limit is asymptotically confirmed. It is also found that Pekeris's second prediction is erroneous. A.

532.51

1409. On the existence of plane, permanent, irrotational flows of incompressible fluids, uniform at infinity. R. GERBER. *C.R. Acad. Sci.* [*Paris*] **235**, 1601–2 (*Dec.* 22, 1952) *In French.*

An irrotational, permanent flow of a perfect liquid, uniform at infinity, both upstream and downstream, and having a given velocity, V, at infinity upstream, and a given delivery is postulated. The domain of flow is limited by a curve S and a line L. The problem posed is to determine, within the undefined band of the complex potential, $f = \phi + i\psi$ the holomorphic and univalent function which permits the conformal representation of the band upon the domain of flow. Conditions ensuring that at least one solution is possible are derived.

J. S. G. THOMAS

532.51

1410. Experimental study of a radial flow of viscous fluid between two parallel planes. R. COMOLET. *C.R. Acad. Sci.* [*Paris*] **235**, 1366–9 (*Dec.* 1, 1952) *In French.*

Experimental results relating to the flow of air between two parallel circular plates from a source at the centre of the plates confirm the validity of the formula derived in a previous paper [Abstr. 1407 (1953)] for the discharge of fluid between the plates.

J. S. G. THOMAS

532.517.4 : 532.574.6

1411. The measurement of turbulent velocity fluctuations by the method of electromagnetic induction. L. M. GROSSMAN AND A. F. CHARWAT. *Rev. sci. Instrum.*, **23**, 741–7 (*Dec.*, 1952).

A method is described for measuring the component velocity fluctuations in the turbulent flow of a fluid by investigating the induced potential gradients in flow transverse to a steady magnetic field. Experimental equipment and procedures for calibration and reduction of data are discussed. Measurements of the r.m.s. component velocity fluctuations in the radial and axial directions for the flow of water in a circular pipe are presented. A.

532.528

1412. The dynamics of small transient cavities. W. D. CHESTERMAN. *Proc. Phys. Soc.* [*London*] *B*, **65**, 846–57 (*Nov.*, 1952).

Experimental methods have been developed for creating and observing single spherical cavities in water and certain organic liquids. Rapid photography permits motion analysis to be made. The cavities show several cycles of expansion and collapse during their lifetime of a few milliseconds. At each volume minimum a sharp pressure maximum occurs in the liquid. It appears that these cavities form initially on minute gas nuclei in the liquids, and the existence of these nuclei is essential for the type of cavitation studied. The relation of cavity life to maximum diameter is discussed. A.

532.59 538.566

1413. On solutions to the wave equation in hyperbolic space. J. W. MILES. Letter in *J. appl. Phys.*, **23**, 1400 (*Dec.*, 1952).

CAPILLARITY 532.6

532.61 : 541.135.5

1414. The influence of a direct-current electric field on the adhesion tension. Z. LÁSZLÓ. Letter in *J. chem. Phys.*, **20**, 1807 (*Nov.*, 1952).

An apparatus is described which will demonstrate the change in the adhesion force between nickel electrodes and a liquid contained between them when an electrical field is applied. While an a.c. field appears to have no effect at all, a d.c. field has a considerable effect in the case of some liquids, probably due to orientation polarization. T. C. TOYE

532.614

1415. Surface free-energy of solid paraffin wax. E. B. GREENHILL AND S. R. MCDONALD. Letter in *Nature* [*London*] **171**, 37 (*Jan.* 3, 1953).

Measurements were made on the change in length of wax filaments, radius (r) is $\sim 0{\cdot}1$ mm, when these were suspended vertically. A critical filament length, l_0, exists for which the elongation of the upper part and the contraction of the lower part (under the

opposing forces of surface free-energy, γ, and weight) are balanced out, and the length remains constant. For a viscous solid, $\gamma = \frac{1}{2}\rho g r l_0$, where ρ is density. Taken in conjunction with other results on liquid wax, a discontinuity in γ at the melting point is revealed, but its temp. coefficient changes little. Measurements have also been made on Sn; γ at 215°C was found to be 685 erg/cm². A. J. KENNEDY

532.69 : 536.423.4

1416. The properties of liquid phase embryos at the intersections of plane solid surfaces. R. G. WYLIE. *Austral. J. sci. Res. A*, **5**, 618–27 (*Dec.*, 1952).

To calculate the probabilities of nucleation of liquid droplets at different types of site on a solid surface, the properties of embryonic droplets which may exist in complete thermodynamic equilibrium at those sites must be known. The general properties of liquid embryos formed on a plane solid surface, or at lines or points of intersection of plane solid surfaces, are considered. It is shown that, although an edge free energy associated with the boundary line may substantially affect the properties of embryos at small contact angles, the effect is probably not large, for embryos of the sizes of interest, when the contact angle is larger than about $\pi/4$. The areas, volumes, total surface free energies, and free energies of formation are found for embryos at these sites as functions of the contact angle, any edge free energies being neglected. The extension to the formation of bubbles at plane solid surfaces in a pure liquid is indicated. The results are applied in a following paper (abstract following) to the kinetics of condensation of a vapour at an imperfect crystalline surface. A.

532.69 : 536.423.4

1417. The condensation of a vapour at a crystalline surface. R. G. WYLIE. *Austral. J. sci. Res. A*, **5**, 628–46 (*Dec.*, 1952).

The theory of self-nucleation in a supersaturated vapour has been developed with considerable success by Becker and Döring (1935), but little attention has hitherto been given to condensation at a solid surface. A theory is given for the nucleation of liquid condensates on a plane surface and at lines and corners formed by the intersection of plane surfaces. It is suggested that the line and corner sites are representative of typical features of real crystalline surfaces. The equilibrium properties and free energies of formation of embryos at these sites, which are required for the nucleation theory, have been given in the previous paper (preceding abstract). The theory shows that the supersaturation for which nucleation proceeds at a just observable rate on a plane surface increases rapidly as the contact angle increases from zero. Unless an edge free energy is introduced, no supersaturation is necessary for nucleation at a line or corner of intersection of plane surfaces when the contact angle is less than a threshold value which depends on the angles between the planes. As the contact angle increases above the threshold value the supersaturation required for observable condensation increases considerably. The effect of contamination of the substrate surface is considered and the suggestions are made that, if a small amount of soluble contamination is present it is likely to become localized at surface steps and corners, sensitizing them as nucleation sites, and that microscopic observation of incipient condensation on solid surfaces may provide a tool for the investigation of surface structure. A.

532.694.1

1418. The rôle of surface transport in the stability and breakdown of foams. W. E. EWERS AND K. L. SUTHERLAND. *Austral. J. sci. Res. A*, **5**, 697–710 (*Dec.*, 1952).

A new theory of foam stability is proposed which demonstrates that the transport of substrate, accompanying a movement of the surface of the bubble film, is a dominant factor in the stability of foams and in the action of foam breakers. The surface moves from a region of low surface tension (high surface pressure) to a region of high surface tension. The surface tension gradients arise from disturbances which may be caused by mechanical or thermal shocks, or by the addition to the surface of particles, droplets, or vapour of a surface-active material. When the surface tension is highest at the centre of disturbance the film will be stable; when the surface tension is lowest at this point the surface film and hence the substrate will be moved away from this point and the film will rupture. A.

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

1419. On the phenomenological relations of Onsager. K. POPOFF. *C.R. Acad. Sci.* [*Paris*] **235**, 648–9 (*Sept.* 29, 1952) *In French.*

With $\Delta S = \frac{1}{2} g_{ik} x_i x_k$ and $x_i = L_{ik} X_k$, the author claims to prove that L_{ik} is determined solely by g_{ik} whose symmetry implies the symmetry of L_{ik}. [This avoids the use of microscopic reversibility. Coriolis and magnetic forces are not mentioned.] R. O. DAVIES

532.7

1420. Notes on the crystallite theory of liquid. A. OOKAWA. *J. Phys. Soc. Japan*, **7**, 543–9 (*Nov.–Dec.*, 1952).

In specifying the interfaces by the crystallite theory of liquid, it is proposed to replace excess boundary energy by excess free energy. A correction is also made to previous procedure in determining the value of the orientational order parameter. With these modifications the theoretical results can be formulated in considerable agreement with the experimental rules, such as Lindemann's formula for the melting point, the melting entropy, and Andrade's formula for the coefficient of viscosity. Just above the melting point, moreover, some abnormalities of the specific heat and of the viscosity coefficient are expected, since structural change is more or less sharp there. A.

532.7

1421. On the Born–Green theory of binary mixtures. G. S. RUSHBROOKE. *Phil. Mag.*, **43**, 1276–82 (*Dec.*, 1952).

The Born–Green equations for binary mixtures are

related to certain approximations to the integrals occurring in Mayer–Montroll expansions of radial distribution functions in powers of density and composition. The significance of the vanishing of the denominator in the resulting formulae is discussed. A.

532.71

1422. Note on the free volume equation of state for hard spheres. L. H. LUND. Letter in *J. chem. Phys.*, **20,** 1977–8 (*Dec.*, 1952).

See Abstr. 7993 (1952). It is considered that the exact solution found by Wood for Kirkwood's integral equation may apply to other types of molecular packing of rigid spheres. F. E. HOARE

532.73

1423. The miscibility break in the barium/barium chloride system. H. SCHÄFER AND A. NIKLAS. *Angew. Chem.*, **64,** *No.* 22, 611 (1952) *In German.*

Confirms the results of Cubicciotti and Thurmond [Abstr. 5285 (1950)]. At the triple phase temperature (878°C), the break extends from 15 to 93 mol-% of Ba; it disappears at 1010°C. F. LACHMAN

532.74

1424. Molecular association in liquids. III. A theory of cohesion of polar liquids. J. A. POPLE. *Proc. Roy. Soc. A*, **215,** 67–83 (*Nov.* 6, 1952).

For Pt II, see Abstr. 2433 (1951). An extension to polar liquids of the cell theory of liquid structure originally developed by Lennard–Jones and Devonshire. The free energy due to dipole interaction is evaluated using a model consisting of point dipoles fixed on the sites of a lattice but free to rotate in the electrical field of all the others. It is shown that, to a first approximation, the total free energy can be expressed as the sum of the free energy of this model and the free energy of a similar liquid without the dipole–dipole forces. The latter can be evaluated by the method of Lennard–Jones and Devonshire. The theory is applied to the polar liquids HCl, H_2S and PH_3. It is found that dipole interaction by itself is not sufficient to explain the difference between the cohesion of these liquids and similar non-polar liquids. The importance of other intermolecular forces between polar molecules is discussed. A.

MECHANICS OF GASES 533

533.15 : 536.423.1

1425. Experiments on the rate of diffusion of a vapour in a gas. J.-M. DUNOYER. *C.R. Acad. Sci.* [*Paris*] **235,** 1027–9 (*Nov.* 3, 1952) *In French.*

Results are presented in a graph of experiments on the rate of evaporation of water (at 22°C) and ice (*c.* 0°C) in a space containing air at pressures varying from *c.* 40 mm Hg down to a fairly good vacuum. The condensing surface has been kept at a temperature below −80°C. It has been found that, for air pressures exceeding the vapour pressure, practically no evaporation can be observed; as soon as the partial pressure of air becomes nearly equal to vapour pressure, the rate of evaporation begins to increase very rapidly, and T' [the final temperature which the evaporating mass assumes, see Abstr. 5352 (1951)] decreases; finally, for air pressures of the order of 1 mm, the evaporation rate remains constant. F. LACHMAN

533.15 : 539.217

1426. The mechanism of diffusion of helium in zircons. P. PELLAS. *C.R. Acad. Sci.* [*Paris*] **235,** 1134–6 (*Nov.* 10, 1952) *In French.*

A calculation of the number of atoms in $ZrSiO_4$ displaced by α-particles from thorium dispersed in it [Abstr. 6146 (1952)] confirms Hurley's theory [Abstr. 9215 (1952)] that helium can only diffuse through such minerals after α-particle damage has taken place. A. R. STOKES

533.5

1427. The Pirani gauge. G. GLOCKLER AND H. VEN HORST. *Science*, **116,** 364–7 (*Oct.* 3, 1952).

The development of the gauge is discussed and a simple design illustrated and described. Temperature control is important and suitable methods are given. The simple gauge can be used in the range 10^{-4} mm to 10^{-1} mm of mercury. For the highest accuracy this type of gauge must be calibrated for each gas and pressure range with which it is to be used. E. H. DOCK

533.5 : 533.7

1428. The pumping speed of a circular aperture in a diaphragm across a circular tube. A. J. BUREAU, L. J. LASLETT AND J. M. KELLER. *Rev. sci. Instrum.*, **23,** 683–6 (*Dec.*, 1952).

Measurements are reported of the pumping speed, for molecular flow, of a circular hole located coaxially in a diaphragm across a circular cylindrical tube. A study is specifically made of the conductance between points not immediately adjacent to the diaphragm but separated by an axial distance L. A theoretical derivation of the conductance leads to the expression

$$KA\left[\frac{1 - A/A_0}{C} + \frac{3}{4}\frac{L}{D_0}\frac{A}{A_0}\right]^{-1}$$

where A and A_0 are, respectively, the areas of the aperture and tube, D_0 represents the diameter of the tube, $K = (RT/2\pi M)^{\frac{1}{2}}$, and C is a dimensionless factor which has been evaluated as a function of relative aperture size. C takes on values from $C = 1$ for A small to $C = 4/3$ for $A = A_0$. The experimental data indicate that the reciprocal of the conductance per unit area of the aperture does vary in an approximately linear fashion with A/A_0, in concordance with the theoretical expression in which the slow variation of the coefficient C is of little effect. It is suggested that knowledge of the pumping speed for the case considered may be of value in measurements of speed at other parts of a kinetic vacuum system. A.

533.5 : 537.56

1429. Methods of obtaining high vacuum by ionization. Construction of an "electronic pump." H. SCHWARZ. *Notas de Fisica, No.* 5, 9 *pp.* (1952).

Calculations on the possibility of obtaining high vacuum in an electrical discharge are given. It is shown that in a simple d.c. gas discharge practically no real pumping action is possible; in such a discharge only clean-up, i.e. electrical adsorption, may

be observed. A real pumping action only results if it is possible to get, within a tube, such a high ion current that the number of ionized gas molecules transported with this current in one direction is greater than the number of gas molecules that will diffuse back in the opposite direction. An electronic high vacuum pump of real pumping action has been built; it starts pumping at about 10^{-3} mm Hg and gives an ultimate pressure lower than 5×10^{-6} mm Hg. A.

533.5 : 621.317.79

1430. A simplified ionization gauge circuit. F. J. Fitz Osborne. *Canad. J. Phys.*, **31**, 11–14 (*Jan.*, 1953).

By measuring the ratio of ion current to electron current present in the usual ionization gauge, an extremely stable circuit has been developed, comparing favourably with standard circuits. A simple calibration made during construction makes this gauge direct reading. The circuit may be used for outgassing the gauge, and for leak hunting, being very sensitive in this respect. It incorporates a safety cut-off. It has relatively few controls, and is cheap. A.

533.6.011.3

1431. The comparison between the longitudinal correlation and the time correlation in a turbulent flow. F. N. Frenkiel. *Phys. Rev.*, **88**, 1380–2 (*Dec.* 15, 1952).

Some preliminary applications of high speed computing to the analysis of experimental data on turbulence are reported. A time correlation curve is determined from a recording of velocity fluctuations measured with a single hot-wire anemometer. The shape of the time correlation curve differs from the shape of the longitudinal correlation curve measured in the same fluid flow. One must, therefore, be cautious in reaching conclusions from experiments based on the assumption that time and space spectra of turbulence are identical. A more extensive study of the relation between time and space characteristics of turbulence is in process. A.

533.6.011.312

1432. The measurement of skin friction in a turbulent boundary layer at a Mach number of 2·5, including the effect of a shock-wave. W. F. Cope. *Proc. Roy. Soc. A*, **215**, 84–99 (*Nov.* 6, 1952).

The skin friction of the wall of a wind tunnel was measured using the surface-tube technique. The Reynolds number (with the distance from the throat as the representative length) was of the order of 2 to 3 millions and the boundary layer was turbulent. The skin friction coefficient was much less than for a very small Mach number (the incompressible case) and the amount of the decrease agreed with calculation. The effect of a shock-wave of strength 2 was also investigated—the strength of a shock-wave is defined as the pressure rise through it divided by the static pressure in front of it. The shock-wave only affected the boundary layer for a few thicknesses upstream of its point of impingement even though it was strong enough to cause local separation. The results show: (*a*) that the surface, or Stanton, tube is a reliable means of measuring skin friction in spite of the large values (over a million with the second as the unit of time) of the velocity gradient at the wall, and that the skin friction coefficient does decrease with Mach number in the manner predicted by calculation; (*b*) that disturbances due to a shock-wave impinging on a turbulent boundary layer are only propagated upstream a few multiples of the boundary layer thicknesses even when the shock-wave is strong enough to cause local separation. A.

533.6.011.4

1433. On the transition through sonic velocity in the efflux of a burning gas. M. Serruys. *C.R. Acad. Sci.* [*Paris*] **235**, 1280–1 (*Nov.* 24, 1952) *In French.*

Expressions are derived for the gradients of velocity and pressure in one-dimensional flow of a perfect, non-viscous and chemically-reacting gas through a conduit of varying cross-section. From these expressions it is shown that: (*a*) so far as pressure and velocity gradients are concerned, the actual flow with energy release or addition can be simulated by a fictitious adiabatic flow through a conduit of different divergence; (*b*) unless the gas velocity W, heat of reaction Q, internal energy E, molecular wt. M, specific ht. ratio γ, velocity of sound a, and conduit section A satisfy the relation $W\partial W/\partial t + (\gamma - 1)(dQ - dE)dt - a^2 d(\ln M)/dt + a^2 W \partial(\ln A)/\partial s = 0$, where s and t are space and time co-ordinates, two shock waves of opposite sense must arise in the transonic region. A. SCHOFIELD

533.6.011.5

1434. On the solution of trans-sonic flow using Laplace transformation. T. Sasaki. *J. Phys. Soc. Japan*, **7**, 625–6 (*Nov.–Dec.*, 1952).

The solution is treated by the use of Laplace transformation in the hodograph method. As an example, the transonic flow past a nearly circular cylinder is calculated. A.

533.6.05

1435. A method for simultaneously measuring the velocity of a fluid and sampling the fluid from the point of measurement. J. A. Leys. Letter in *Research*, **5**, 439–40 (*Sept.*, 1952).

The turbulent mixing of two gas streams (air) is studied by introducing a tracer (CO_2 or CH_4) into one stream and continuously measuring its concentration in the field of mixing, e.g. by an i.r. gas analyser, and measuring the stream velocity by a Pitot tube. The technique is simplified by the use of a combined total head tube and a surrounding sampling probe. Static pressure is measured at some other point, e.g. at the wall, and must be fairly constant or invariable. It is intended to transform both tracer concentration and velocity into electrical signals, and to perform the subsequent multiplication and integration electrically. J. S. G. THOMAS

533.6.08

1436. New applications of hot-wire anemometry. G. Dätwyler. *C.R. Acad. Sci.* [*Paris*] **235**, 1101–3 (*Nov.* 10, 1952) *In French.*

It is shown theoretically that (1) owing to the existence of thermal fluctuations in a flow measured by a hot-wire anemometer, the kinematic turbulence measured by the wire will be a function of the temperature of wire and hence will depend upon the heating

current and differ from the correct value except under a specified condition; (2) a definite condition must be satisfied before the indication of a minimum of thermal turbulence by a hot-wire anemometer can be accepted as indicating that a hot-wire resistance thermometer used for measuring flows at high temperatures is heated at exactly the requisite mean temperature. Heating of the leads is necessary, in this case, to compensate for loss of heat by radiation, etc. J. S. G. THOMAS

533.6.08

1437. The IMFL anemoclinometer—an instrument for the investigation of a fluctuating velocity vector. A. MARTINOT-LAGARDE, A. FAUQUET AND F. N. FRENKIEL. *Rev. sci. Instrum.*, **23**, 661–6 (*Dec.*, 1952).

The IMFL anemoclinometer is an instrument measuring the magnitude and direction of a fluctuating fluid velocity. As a result of a measurement, three pressure differences are obtained from which the vector velocity is found. Contrary to some similar instruments, the anemoclinometer is not moved during a test and can, therefore, be easily used to obtain recordings. Three variants are described, and their application to experimental measurements is discussed. A.

MOLECULAR THEORY OF GASES 533.7

533.7 : 536.71

1438. The third virial coefficient of ethane. H. G. DAVID, S. D. HAMANN AND R. G. H. PRINCE. Letter in *J. chem. Phys.*, **20**, 1973 (*Dec.*, 1952).

Estimates of this coefficient, obtained from an analysis of compressibility measurements, differ widely from the experimental values given by Bird, Spotz and Hirschfelder [Abstr. 899 (1951)] (which, it is claimed, are based on a faulty analysis of the experimental results), and are in reasonable agreement with the theoretical values calculated by these authors. E. H. SONDHEIMER

533.71

1439. The virial theorem in the Thomas–Fermi theory. N. H. MARCH. *Phil. Mag.*, **43**, 1042–6 (*Oct.*, 1952).

A discussion of the virial theorem for both Thomas–Fermi and Thomas–Fermi–Dirac systems is given, the results being more general than have hitherto been obtained. Finally the particular case of a homonuclear diatomic molecule is briefly considered. A.

VIBRATIONS . ACOUSTICS 534

534.01

1440. On the theory of stable vibrations of an elastic semispace. L. YA. GUTIN. *Zh. tekh. Fiz.*, **21**, 892–906 (*No.* 8, 1951) *In Russian.*

Asymptotic expressions are derived, on the basis of Lamb's formulae, laws of reflection of two-dimensional elastic waves and the reciprocity principle, for displacements in a surface wave and within a semi-space, for the most important types of sources (vertical, horizontal and double forces, compression centre) changing with time according to the simple harmonic law. A. GELBTUCH

534.01 : 538.55 : 621.392 : 621.3.012.8

1441. Duality in mechanics. P. LE CORBEILLER AND Y.-W. YEUNG. *J. Acoust. Soc. Amer.*, **24**, 643–8 (*Nov.*, 1952).

Given an electric network E_v which has M meshes and P node-pairs, its electric dual E_i will have P meshes and M node-pairs and its classical mechanical analogue M_f will have $M + 1$ nodes, M independent node-pairs, and P independent node cycles. A second mechanical system M_v, the classical analogue of E_i, will have M cycles and P node-pairs. If, for example, $M = 2$, $P = 3$, the systems E_v and M_v, analogues in the Firestone or "mobility" method, will be governed by two mesh equations, expressing that the algebraic sum of the voltages or velocities around any loop is zero, the systems E_i and M_f, also Firestone analogues, will satisfy two node equations, expressing that the algebraic sum of the currents or forces leaving any node is zero. These four sets of equations are identical, interchanging symbols suitably. The consideration of the four systems, E_v, E_i, M_v, M_f, forming a complete set, shows the advantages of the Firestone over the classical system of analogues and suggests a systematic use of duality in mechanical as well as in electrical systems. A.

534.013

1442. Calculation of torsional vibrations by the theory of effective masses. T. O'CALLAGHAN. *Frequenz*, **6**, 267–72 (*Sept.*, 1952) *In German.*

When a rotating system comprises $n + 1$ masses having inertia J_0 to J_n joined by n intermediate shafts having a flexibility F_1 to F_n, the effective inertia of the system can be computed to give the condition that the whole system behaves as one unit having an inertia J_{eff}. When the effective inertia is computed for several frequencies it is found that, in passing from one to the next, the sign of J_{eff} changes and a resonance frequency lies between the two frequencies and can then be computed with accuracy by a trial and error technique. The special case considered is the effective inertia of a multi-element system which can be broken down into a number of single masses attached to short lengths of shaft, and similarly into a system of two masses attached to opposite ends of one short length of shaft. A. C. WHIFFIN

534.013

1443. The arithmetical calculation of effective mass, resonant frequency, torsional moments and deformation of rotational vibrating systems. T. O'CALLAGHAN. *Frequenz*, **6**, 295–304 (*Oct.*, 1952) *In German.*

The theory reported in the preceding abstract is employed to solve, by a tabular technique, the problems of masses rotating on shafts. The calculations are made for various rotational frequencies. Using the symbols given in the previous paper, the case first considered has four masses of inertia J_0 to J_3 joined by three shafts of flexibility F_1 to F_3. The calculations show that the effective inertia changes sign at three

different frequencies which are the resonant frequencies. The torsional moments are computed from the tabular data obtained while computing the effective inertia and, from these results, the angular displacement of the various parts of the shaft are calculated. Several other systems of loaded shafts are investigated to illustrate the tabular technique of solving the problems. A. C. WHIFFIN

534.11

1444. On stability conditions of a linear system. L. A. VARSHAVSKIĬ. *Zh. tekh. Fiz.*, **21**, *No.* 8, 907–19 (1951) *In Russian.*

Stability conditions are derived in a form which facilitates the choice of coefficients in the frequency equation of a linear system, such as to make the system stable (no roots with positive real parts).

A. GELBTUCH

534.138

1445. Damped oscillations of a sphere in a viscous fluid. J. VALENSI AND C. CLARION. *C.R. Acad. Sci.* [*Paris*] **235**, 1097–9 (*Nov.* 10, 1952) *In French.*

The application of Stokes' theory to the oscillations (of finite amplitude) of a sphere in a real fluid.

T. C. TOYE

534.21

1446. Critical length for the propagation of sound in a viscous fluid. C. TRUESDELL. *C.R. Acad. Sci.* [*Paris*] **235**, 702–4 (*Oct.* 6, 1952) *In French.*

An expression is derived for the critical length l_c, and it can be seen that very short lengths would be considerably overdamped (otherwise known as frequency cut-off). The effect of thermal conduction is ignored. T. C. TOYE

534.21

1447. Demodulation of ultrasonic waves in liquids. K. ALTENBURG AND S. KÄSTNER. *Ann. Phys.* [*Leipzig*] **11**, *No.* 2–3, 161–5 (1952) *In German.*

An investigation is carried out at constant energy density of the carrier and also at constant modulation gradient. It is shown that the theory is correct in these cases. T. C. TOYE

534.22

1448. The velocity of ultrasonic waves in metals. N. F. OTPUSHCHENNIKOV. Letter in *Zh. eksper. teor. Fiz.*, **22**, *No.* 6, 782–3 (1952) *In Russian.*

Values are given for a frequency of 3·5 Mc/s for Duraluminium, aluminium, steel, magnesium, nickel, four kinds of brass, zinc, tin and lead. They decrease from 6860 m/sec for Duraluminium to 2200 m/sec for lead and mainly decrease with increasing density. The accuracy of the values vary between 40 and 80 m/sec. J. M. HOUGH

534.222.2

1449. Limitation of gradients and their logarithmic derivatives in shock waves by Chapman's formulae. S. TRAVERS. *C.R. Acad. Sci.* [*Paris*] **235**, 1099–1101 (*Nov.* 10, 1952) *In French.*

534.23 : 535.41

1450. On a beat wave-length type acoustic interferometer. T. YASUNAGA AND K. HUKUDA. *Mem. Fac. Sci. Kyūsyū Univ. B*, **1**, *No.* 2, 61–3 (*March*, 1952).

Apparatus is described for accurately measuring differences in the velocity of sound in 2 miscible or non-miscible liquids which have nearly the same velocity. The liquids are contained in the same vessel and if they are miscible they are separated by a thin celluloid plate. The location of the 2 nodal planes nearest to the resonator and reflector are determined and then the separating plate or the liquid interface is displaced and the position of the nodal planes again determined. The difference in sound velocity is deduced from a theoretical expression in which account is taken of the correction term for the phase discontinuities at the boundaries between the separator and the liquid media. Using distilled water as one medium and an aqueous solution of NaCl (0·1031 mol/litre) as the other, the velocity difference observed at 20°c was $7{\cdot}21 \pm 0{\cdot}03$ m/sec, compared with 7 ± 1 m/sec obtained by the usual Pierce type of moving reflector interferometer. H. J. H. STARKS

534.23 : 535.41

1451. On a F–M type acoustic interferometer. Z. MIDUNO AND K. HUKUDA. *Mem. Fac. Sci. Kyūsyū Univ. B*, **1**, *No.* 2, 54–7 (*March* 1952).

A theoretical treatment is given of the acoustic interferometer in the case when the reflector is immersed in liquid and when one face of the reflector or a quartz resonator is coupled to a liquid column and the other face is backed by air. In the latter case, the correction, which must be applied so that the acoustic path of a liquid column shall be an integral multiple of half-wavelengths, varies with frequency. The theory is checked by measurements of the correction term using an air-backed X-cut quartz crystal in water as the resonator and the free surface of the water as the reflector. A F–M oscillator circuit is used to excite and measure the standing wave system, the resonance frequency being measured to an accuracy of about 1 kc/s at about 1·5 Mc/s.

H. J. H. STARKS

534.23 : 535.41

1452. On a substitution type acoustic interferometer. Z. MIDUNO AND K. HUKUDA. *Mem. Fac. Sci. Kyūsyū Univ. B*, **1**, *No.* 2, 58–61 (*March*, 1952).

The correction term mentioned in the preceding abstract affects the validity of the results obtained with the type of interferometer in which the displacements of the nodal and antinodal planes in a liquid medium are observed when a parallel slab of solid is placed in the sound beam. A theoretical treatment is given of the corrections to be applied and an experimental procedure is suggested. H. J. H. STARKS

534.23

1453. Ultrasonic method of tire inspection. W. E. MORRIS, R. B. STAMBAUGH AND S. D. GEHMAN. *Rev. sci. Instrum.*, **23**, 729–34 (*Dec.*, 1952).

The principles of a method are discussed for detecting internal defects in pneumatic tyres, such as ply separations, by the attenuation of transmitted ultrasonic waves. Equipment for carrying out tyre inspections by this method is described. It includes provisions for inspecting a large range of tyre sizes, scanning the tread region from shoulder to shoulder and is suitable for operation by inspection personnel. A useful form for recording the results of a tyre inspection is described. One of the principal applications for this method of inspection is the examination of tyres to determine their suitability for recapping. A.

534.23

1454. Ultrasonic absorption in various organic liquids at 15 Mc/s. S. PARTHASARATHY, S. S. CHARI AND D. SRINIVASAN. Note in *Naturwissenschaften*, **39**, *No.* 20, 483 (1952).

Absorption measurements have been made at 15 Mc/s to fill the gap between 5 Mc/s and 30 Mc/s, there being very little information concerning this region. T. C. TOYE

534.23 : 535.417

1455. Ultrasonic interferometry in gases. II. Ultrasonic dispersion in methyl chloride. S. PETRALIA. *Nuovo Cimento*, **9**, 351–7 (*April*, 1952) *In Italian.*

Using an interferometer described in Pt I [Abstr. 905 (1951)], the author has measured the velocity of sound in methyl chloride over a large field of pressures and for three different ultrasonic frequencies. From the dispersion curve so obtained, the molecular heat capacity due to the internal vibrations of the molecule, the relaxation time of the vibration energy and the number of collisions required for the disexcitation of the quantic states of vibration are calculated. A.

534.23 : 537.226.2

1456. Dielectric and ultrasonic relaxation in glycerol. T. A. LITOVITZ AND D. SETTE. *J. chem. Phys.*, **21**, 17–22 (*Jan.*, 1953).

Measurements of dielectric and ultrasonic relaxation in glycerol are compared over a frequency range of 7·5 to 37·5 Mc/s and over a temperature range from 20°C to −25°C. Reduced dielectric and ultrasonic constants when plotted against viscosity at a constant frequency of 30 Mc/s appeared quite similar. The imaginary (or loss) part of the reduced constants exhibited a peak at the same viscosity. Both phenomena exhibited a departure from a single relaxation time theory. This deviation of the dielectric phenomena from the simple theory was attributed in the usual manner to a distribution of relaxation times. The striking similarities in the behaviour of the dielectric and ultrasonic phenomena suggests an intimate relation between the two. Thus, if a distribution of relaxation times exists for the dielectric it should in all probability exist in the ultrasonic process. Both shear and compressional viscous processes are associated with the acoustic phenomena. It was concluded that if any difference exists in the shear and compressional viscous relaxation times, its effect is masked by a probable distribution in relaxation times for each process. Calculations indicated that the natural "rotational jump" time in glycerol is between $\frac{1}{2}$ and 4 times the "translational (or viscous) jump" time. A.

534.23 : 539.13

1457. Energy transfer by collisions in *cis*- and *trans*-dichloroethylene vapors. D. SETTE, A. BUSALA AND J. C. HUBBARD. *J. chem. Phys.*, **20**, 1899–1902 (*Dec.*, 1952).

Some recent measurements by Sette of ultrasonic absorption in liquid halogenated hydrocarbons [e.g. Abstr. 103, 104, 2512, 2514 (1952)] have indicated strong structural differences upon which, it was hoped, further light would be given by a study of some of these compounds in the vapour state. Ultrasonic velocity and absorption in *cis*- and *trans*-dichloroethylene have been measured at 34·7°C, at frequencies of 0·425, 1·985 and 2·982 Mc/s and at pressures from 12 to 250 mm Hg, giving a range of f/p of 1·27 to 125 Mc/s atmos. The results show that energy equilibrium in the molecule is more quickly attained in the *trans*- than in the *cis*-form. Without consideration of departure from the ideal gas law, the results may be explained by the assumption of two regions of f/p in which relaxation occurs, one relaxation frequency of 3·5 Mc/s atmos being common to both, there being also one of 30 for the *cis* and 90 for the *trans*. The molecular absorption per wavelength computed from dispersion data are in good qualitative agreement with those measured. The values of C_v/R for both forms fall from 7·5 at one Mc/s atmos to about 3·5 at 100 Mc/s atmos. The results indicate the pre-eminent importance of short-range forces in determining the energy transfer by collisions. A.

534.23 : 541.14

Relations between the wavelength and the oxidation of potassium iodide by ultrasonics. *See Abstr.* 2018

534.231

1458. An exact solution of the acoustical field near a circular transducer. E. W. GUPTILL. Letter in *J. Acoust. Soc. Amer.*, **24**, 784 (*Nov.*, 1952).

The purpose of the letter is to point out that an exact solution for the entire acoustical field of an extended source is possible if the ordinary boundary conditions are only slightly altered. A. B. WOOD

534.232

1459. The radiation impedance of ribbon type sound radiators, and the vibro-motive force on them. T. NIMURA AND K. SHIBAYAMA. *Rep. Res. Inst. Elect. Commun Tôhoku Univ.*, **3**, *No.* 2, 77–85 (1951).

Using Mathieu functions, the mathematical analysis of the acoustic radiation from a vibrating ribbon with a ribbon-type baffle board of finite width and the acoustic scattering by a rigid ribbon is developed. The effect of the baffle board on sound radiation and the vibro-motive force on it are given. A.

534.232

1460. On sound radiation from a plate in complex types of vibrations. A. V. RIMSKIĬ-KORSAKOV. *Zh. tekh. Fiz.*, **21**, *No.* 8, 970–85 (1951) *In Russian.*

A method is presented for evaluating sound radiation at frequencies above the fundamental from a plate subjected to a sinusoidal force of constant amplitude. The method is applied to a simplified piano sound-board. A. GELBTUCH

534.232 : 537.228.1

1461. On the characteristics of miscellaneous piezoelectric vibrators in stiffness control. S. HONDA. *Rep. Res. Inst. Elect. Commun Tôhoku Univ.*, **3**, *No.* 2, 95–114 (1952).

The electromechanical coupling factor of the vibrators in stiffness control was defined, and a comparison of the efficiencies of the vibrators was made, using this factor. The effect of an elastic plate inserted between two piezoelectric crystal plates in the bimorph-type vibrator was described. The electrical, mechanical and electro-mechanical constants of miscellaneous vibrators in stiffness control are listed. A.

534.232 : 621.395.61

1462. Theoretical sensitivity of a transversely loaded, circular bimorph transducer. E. G. THURSTON. *J. Acoust. Soc. Amer.*, **24**, 656–9 (*Nov.*, 1952).

With the advent of barium titanate as a piezoelectric material, the construction of transducers whose active elements can be in a wide variety of shapes became possible. The theoretical sensitivity of an interesting structure consisting of a transversely loaded, centrally supported, circular, barium titanate bimorph is calculated using the results of elasticity theory. Some experimental verification is presented. A.

534.24

1463. The reflexion of a spherical acoustic pulse by an absorbent infinite plane and related problems. P. E. DOAK. *Proc. Roy. Soc. A*, **215**, 33–53 (*Nov.* 25, 1952).

A formal integral solution is given for the problem of the reflection of a spherical acoustic pulse by an infinite plane interface having an impedance of arbitrary dependence on frequency and angle of incidence. In many cases of practical interest the impedance may be assumed to be independent of angle of incidence, and under this assumption the integral solution is relatively easy to evaluate. A simple exact expression for the reflected pulse, in closed form, is obtained when the wall impedance is purely resistive (i.e. independent of frequency). This solution is a special case of a general type of solution of the wave equation when it is reduced to a rotationally symmetric Laplace's equation in the "spherical polar" co-ordinates

$$\left\{\sqrt{[(ct/r)^2-\sin^2\theta]}, \left(\frac{ct\cos\theta}{r}\right)\Big/\sqrt{[(ct/r)^2-\sin^2\theta]}\right\}$$

To illustrate the relatively wide range of validity of the assumption of an impedance independent of angle of incidence, when applied to real materials, this exact result is compared with an approximate solution for the case where the interface separates two homogeneous isotropic lossless materials. The formal integral solution is evaluated approximately for wall impedances of the following types: (i) resistance and mass, (ii) resistance and stiffness, (iii) resistance, mass and stiffness. The solutions are compared with corresponding solutions for plane incident waves, and the behaviour of the scattered wave, distinguishing between the spherical and the plane wave, is discussed. Possible applications of the results for acoustic waves to problems in the reflection of blast waves and of transient radiation by an electric dipole are indicated briefly. A.

534.26 538.566

1464. Removal of an inconsistency in the theory of diffraction. D. S. JONES. *Proc. Cambridge Phil. Soc.*, **48**, *Pt III*, 733–41 (1952).

It is indicated by means of a particular example how an inconsistency arises in one formulation of diffraction problems. It is shown that the inconsistency is removed if different boundary conditions are imposed during the formulation. In the proof it is necessary to determine the contributions to the field from parts of a sphere of radius R at an interior point when the field on the sphere is a plane wave. It is found that, as $R \to \infty$, the part of the sphere near the source which subtends a solid angle of order $R^{2\varepsilon-1}(0 < \varepsilon < \frac{1}{10})$ at the centre contributes the plane wave and that the remainder of the sphere provides a contribution which vanishes in the limit. The demonstration involves the use of the principle of stationary phase for an integral of two variables. In the final section special boundary conditions are given for an exceptional three-dimensional problem. A.

534.26 : 541.182

1465. Scattering of sound in dispersion systems. V. K. MICHURIN AND L. A. CHERNOV. *Zh. tekh. Fiz.*, **21**, *No.* 8, 920–6 (1951) *In Russian.*

The coefficient of sound scattering is calculated for sound wave propagating (i) in heavy suspensions (e.g. fog), and (2) emulsions (e.g. 10% benzene in water). A. GELBTUCH

534.32

1466. Study and representation of the complex note in musical acoustics. A. MOLES. *Ann. Télécomm.*, **7**, 430–8 (*Nov.*, 1952) *In French.*

A musical signal is not completely determined by the curves of amplitude and pitch as functions of time and it is pointed out that a 3-dimensional diagram relating amplitude, pitch and time, is required. It is shown that a musical signal contains definite elements which are termed "complex tones." The tridimensional diagram is discussed and an experimental method of recording it is outlined. G. F. HODSMAN

534.39

1467. Thermal and haemolysis effects of ultrasound. H. FARK. *Frequenz*, **6**, 255–6 (*Sept.*, 1952) *In German.*

Describes very briefly a study of the thermal biological (haemolysis) effects produced in blood suspensions through which high frequency (960 kc/s) sound waves are passing. In one arrangement a system of stationary waves is set up between the surface of the sound source and a parallel plane reflector. In a second arrangement a pair of concave focusing mirrors is used. Curves are shown indicating the rise of temperature with time using (*a*) distilled water (uniform linear heating), (*b*) suspension of 1/50 blood corpuscles in formaldehyde solution, and (*c*) 1/50 blood corpuscles in Ringers' solution. The curves (*b*) and (*c*) show concavities at the point where haemolysis sets in. A. B. WOOD

534.39

1468. Intensity measurement of ultrasound. H. FARK. *Frequenz*, **6**, 256 (*Sept.*, 1952) *In German.*

In continuation of the previous paper (preceding abstract) the author describes how he uses the rise of temperature of the water contained in a small calorimeter in which a quartz transducer is immersed, to measure the energy output (sound intensity) of the quartz. A curve is shown which connects sound intensity with galvanometer deflection. A. B. WOOD

534.521 : 537.228.1

1469. Vibrations of "textural" piezoelectric Rochelle salt laminae. V. P. KONSTANTINOVA AND A. V. SHUBNIKOV. *Zh. tekh. Fiz.*, **21**, *No.* 8, 962–9 (1951) *In Russian.*

Vibrations at sound frequencies of plain and bimorphous rectangular piezoelectric textures (anisotropic laminae with an axis of infinite order along the direction of the fibres), the preparation of which

was described by Shubnikov (1944), have been investigated by observing Chladni figures produced by white sand spread over the surface of the laminae, and by measuring the amplitudes with a microscope. Graphite layers deposited on both sides of the laminae, sometimes in sections insulated from each other and connected in various ways, served as electrodes. A. GELBTUCH

534.632

1470. An accurate method of measuring frequency in the audio range. A. F. B. NICKSON. *J. sci. Instrum.*, **29**, 391–3 (*Dec.*, 1952).

Frequency in the audio range is commonly measured by means of a stable oscillator capable of being accurately calibrated in comparison with signals of known frequency close to the range of frequencies in which the measurements are to be made. The equipment described makes use of this method, but is an advance on the simpler equipment generally used in that each frequency to be measured is compared with one standard frequency of known accuracy. Unknown frequencies may then be measured with similar accuracy. A.

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 2116

534.78

1471. Dynamic spectrograms of speech. W. E. KOCK AND R. L. MILLER. Letter in *J. Acoust. Soc. Amer.*, **24**, 783 (*Nov.*, 1952).

The paper refers to modifications in the conventional sound spectrograph. In essence this involves the differentiation of the time-amplitude pattern for different points of the spectrum, rather than the use of the time-amplitude function directly. "Dynamic" spectrograms are reproduced illustrating different methods of portraying the manner in which the spectrum energy is changing with time. These spectrograms illustrate speech sounds recorded by the various methods described. A. B. WOOD

534.78 : 621.391

1472. The problem of selective voice control. W. E. KOCK. *J. Acoust. Soc. Amer.*, **24**, 625–8 (*Nov.*, 1952).

The development of devices which can be operated automatically from the phonetic content of speech may be viewed in terms of the more general problem of the reduction of channel capacity in communications systems. Significance has been observed in formant positions and movements as regard the identification of speech sound. The basic problems in the derivation of phonemes from the formant patterns are reviewed. A.

534.78 : 621.395.6

1473. Automatic recognition of spoken digits. K. H. DAVIS, R. BIDDULPH AND S. BALASHEK. *J. Acoust. Soc. Amer.*, **24**, 637–42 (*Nov.*, 1952).

The recognizer discussed will automatically recognize telephone-quality digits spoken at normal speech rates by a single individual, with an accuracy varying between 97 and 99%. After some preliminary analysis of the speech of any individual, the circuit can be adjusted to deliver a similar accuracy on the speech of that individual. The circuit is not, however, in its present configuration, capable of performing equally well on the speech of a series of talkers without recourse to such adjustment. Circuitry involves division of the speech spectrum into two frequency bands, one below and the other above 900 c/s. Axis-crossing counts are then individually made of both band energies to determine the frequency of the maximum syllabic rate energy within each band. Simultaneous two-dimensional frequency portrayal is found to possess recognition significance. Standards are then determined, one for each digit of the ten-digit series, and are built into the recognizer as a form of elemental memory. By means of a series of calculations performed automatically on the spoken input digit, a best match type comparison is made with each of the ten standard digit patterns and the digit of best match selected. A.

534.833

1474. Acoustic resonators as sound absorbers. A. LAUBER. *Tech. Mitt. PTT*, **30**, *No.* 7, 209–13 (1952) *In German and French.*

For the absorption of low frequency sounds in room acoustics suitable resonators can be used. Two types of absorbing resonators are described which have been studied under laboratory conditions and in actual practice. The first of these consists of a repetition of a series of four pipe resonators (closed at one end) of lengths 90, 75, 50 and 40 cm, having fundamental frequencies 96, 115, 172 and 215 c/s respectively. The wall panelling is covered with the resonators. The second type is a hollow absorbent brick, the cavity having a hole to convert it into a Helmholtz resonator of frequency controlled by the dimensions of the hole (and neck) and the volume of the cavity in the brick. A series of curves are reproduced relating the sound absorption and frequency, for the various arrangements. A. B. WOOD

534.862.3 : 534.839

1475. The use of binaural tape recording in automotive noise problems. D. C. APPS. *J. Acoust. Soc. Amer.*, **24**, 660–2 (*Nov.*, 1952).

The record-playback method of making noise comparison tests provides realistic answers with a minimum of equipment and sophistication. Such a method is especially attractive in problems handled by making experimental changes which, taken individually, usually produce very small changes in level and quality of noise. In automotive work, playback of single-channel recordings of interior car noise sensed by a single microphone sound unreal because of an emphasized bass, the cause of which is not known. Directional effects also contribute to the lack of realism. The use of a binaural magnetic tape recorder improves realism, which in turn enhances the resolution of smaller differences. A.

OPTICS . RADIATION . SPECTRA 535

535.14 : 535.41

1476. Interpretation of an interference phenomenon by observers in relative motion. M. RISCO. *J. Phys. Radium*, **13**, 441–4 (*Oct.*, 1952) *In French.*

Moving fringes produced by two beams of equal amplitudes, but of different frequencies and directions,

are reduced to a stationary system by a Lorentz transformation to a suitable frame of reference S'. A corpuscular interpretation is then given in terms of particles of non-zero rest-mass at rest relative to S'. Equivalent results are obtained by application of the principles of conservation of energy and momentum to collisions between photons, two particles being formed per collision. R. A. NEWING

535.214.6

1477. Theory of negative photophoresis. Supplement to two previous notes. P. TAUZIN. *C.R. Acad. Sci.* [*Paris*] **235**, 1119–21 (*Nov.* 10); Erratum, 1718 (*Dec.* 22, 1952) *In French.*

See Abstr. 6335 (1950), 7132 (1952). Photophoresis is regarded as a radiometric effect, arising from the differential heating of the two sides of a small suspended particle. Whether the side facing the incident radiation is heated more than the other side depends on the extent to which the radiation is absorbed by the different sections of the particle, and on the amplitude and direction of the scattered radiation. Thus changes in wavelength or particle size may cause a reversal in sign of the photophoresis. N. CORCORAN

535.23.08

1478. The general theory of bolometer performance. R. C. JONES. *J. Opt. Soc. Amer.*, **43**, 1–14 (*Jan.*, 1953).

A general phenomenological theory of the static and dynamic behaviour is presented. The theory assumes as given the fundamental relations between the temperature and resistance of the bolometer, and the past history of the power dissipated within it. From these basic properties are derived a number of the properties of more immediate interest, such as electrical impedance, responsivity as a function of frequency, and the static load curve. Several equivalent circuits are developed to represent the behaviour of the bolometer as a function of frequency at a single operating point. A two-terminal equivalent circuit is described that represents the electrical impedance as a function of frequency. In order to represent the response of the bolometer to incident radiation as a function of frequency, a four-terminal equivalent circuit is described. An electrical bridge is described that permits one to measure by purely electrical means the electrical response that a bolometer would have to radiation of any given time dependence, including radiation that varies sinusoidally. By purely electrical means and without the need of a radiation source (calibrated or otherwise), the bridge provides a precise measurement of the bolometer's responsivity (output volts per watt of incident radiation) as a function of frequency. An electrical signal $S(t)$ at the input of the bridge produces the same electrical output as would be produced in the normal use of the bolometer by a radiation signal with the same wave form as $S(t)$. A.

535.23.08

1479. Properties of thermistor infrared detectors. E. M. WORMSER. *J. Opt. Soc. Amer.*, **43**, 15–21 (*Jan.*, 1953).

Thermistor bolometers are fast, sensitive infrared detectors with good responsivity from 1 to 15 microns. The detectors consist of a thin flake of thermistor material mounted on a thermal sink. The time constant of the detectors is determined by the type of thermal sink on which the flakes are mounted. By cementing thermistor flakes to quartz or glass thermal sinks, detectors with time constants ranging from 3 to 5 and 5 to 8 milliseconds, respectively, are obtained. Experimental results are given for quartz- and glass-backed thermistor detectors having sizes of sensitive areas ranging from 0·2 to 12·5 mm². Performance criteria for these detectors are tabulated and plotted as a function of size of sensitive area. Typical frequency response and relative spectral responsivity data are given. Detector flakes have to be mounted in sealed housings for noise-free operation. Two types of housings are described. A.

535.24 : 535.312

1480. Notes on the errors associated with reflectometers using photometric sphere. Z. YAMAUTI. *Japan Sci. Rev.*, **2**, 11–12 (*April*, 1951).

The Hardy spectrophotometer employs a sphere with four apertures, two of these being occupied respectively by the test sample and the standard surface. The author calculates, for different sizes of the apertures, the error introduced into the measurement of reflection factor if this is very different from that of the standard. Similarly, the error in a measurement of reflection factor made with the Taylor absolute reflectometer is calculated for different sizes of the aperture occupied successively by the test surface and the standard. J. W. T. WALSH

535.31

1481. Supplementary note on ray tracing. T. SMITH. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 822–3 (*Oct.*, 1952).

This note describes two additions to previous ray tracing methods due to Smith (1920, 1945). These relate to the difference in path for a ray lying in an axial plane, and to the method of determining the co-ordinates of the point of intersection of a ray and a surface. The original procedure sometimes failed to converge, and the new method gives an alternative procedure for these cases. R. W. FISH

535.31

1482. Graphical solutions to optical problems of three different types. E. J. IRONS. *Amer. J. Phys.*, **21**, 1–10 (*Jan.*, 1953).

I. Paraxial ray tracing by the focal plane method.—For spherical refracting and reflecting surfaces it is shown that by drawing two secondary axes, one parallel to a ray incident at an arbitrary angle and the other parallel to the path of the same ray after refraction or reflection, the positions of the focal planes are readily established and their necessary properties deduced. The same is done for a lens by a method based on the fact that a focal plane of the first surface is conjugate to a focal plane of the second surface.

II. The variation in the distance L between the conjugate foci of a thin lens (focal length f) with the distance l of one focus from the lens.—A general formula is established, and a simple construction for plotting the graphs between L/f and l/f is described.

III. Refraction by prism combinations and the

prism refractometer.—A graphical method is used to discuss the design of the Amici prism, the direct vision spectroscope, and achromatic prisms giving appreciable deviations. A graphical method is also described for finding the refractive index of a liquid from results obtained with a prism refractometer. A.

535.313

1483. Computation of spherical-mirror systems by means of finite-difference equations. L. P. RAITIERE. *J. Opt. Soc. Amer.*, **42**, 960–5 (*Dec.*, 1952).

Develops and demonstrates a new procedure involving a finite difference equation. The method offers several advantages, such as a direct analytical approach to and exact solutions of problems of spherical aberration and coma. A numerical example is given. Although the two-mirror case is demonstrated, the method is equally applicable to three mirrors. A.

535.316

1484. An "algebra" of possibilities relating regions in object and image space for a system of thin lenses. R. A. SATTEN. *J. Opt. Soc. Amer.*, **42**, 955–9 (*Dec.*, 1952).

A method is presented of associating to each thin lens a matrix operator which transforms a finite number of regions of object space into regions of image space. By making use of the fact that the logical relation "or" has properties similar to the ordinary notion of addition, a single matrix which represents the transformation properties of a combination of any number of thin lenses axially alined can be obtained by matrix multiplication. It is thus possible to store in a single resultant matrix all the information as to possible locations of an image in any of a finite number of regions covering image space, when the object is located in any of the similarly divided regions of object space. The method is very simple in principle and practice, and it is hoped that the loss of information due to the treating of whole regions together will result in an increase in the speed and facility with which one might determine the general features of a system of lenses. A.

535.317

1485. A variable prism unit for range finders. H. ASHER. *J. sci. Instrum.*, **29**, 402–3 (*Dec.*, 1952).

A variable prism unit is described in which the effective angle of the prism is varied by a linear movement of one of the parts. The application of this unit to range finders is discussed, and it is shown that when fitted to a camera, the linear movement of the moveable part of the range finder may be made equal to the movement of the camera lens required for focusing. A.

535.317.5

1486. Reducing aberrations in rotating-prism compensators for nonintermittent motion pictures. G. SCHWESINGER. *J. Opt. Soc. Amer.*, **42**, 923–30 (*Dec.*, 1952).

Optical compensators of the rotating-plate principle are widely used for their simplicity in motion picture equipment of various types. Despite many attempts, little improvement of their optical performance has been achieved. Some competent proposals to this aim and their optical limitations are briefly discussed. A novel type of compound compensator is theoretically investigated, utilizing two refracting "plates" whose indexes are respectively greater and less than one. It is shown how such a device can be practically realized and what requirements exist for the selection of suitable optical materials. Inasmuch as materials available at present permit the aberrations to be reduced by more than a factor of five, the proposed compound compensator seems to promise substantial improvement within practical reach. A.

535.322.4 : 535.417

1487. A new method of measuring small refractive index differences. H. SVENSSON AND K. ODENGRIM. *Acta chem. Scand.*, **6**, 720–8 (1952).

A method for measuring small refractive index increments based on interferometric measurement [see Abstr. 1216 (1948) 5693 (1952)] of the optical thickness of a double-prism cell in monochromatic light is described. It is capable of a precision of 1×10^{-6} refractive index units, and the fringe density is shown to be proportional to the refractive index difference within a wide range, the limit of which is given mathematically. The method is expected to be of value for rapid and accurate measurements of concentrations of solutions, especially in laboratories where electrophoresis or diffusion apparatus with astigmatic optical systems are available. A.

535.33 : 535.375.5

1488. Summarized proceedings of the third international spectroscopy colloquium—Hoddesdon, September 1952. D. M. SMITH. *Brit. J. appl. Phys.*, **3**, 369–72 (*Dec.*, 1952).

The colloquium was arranged by the Industrial Spectroscopy Group of The Institute of Physics. The subjects covered were: Detectors of radiation, spectroscopic light sources, emission spectroscopy, direct reading spectroscopy, infra-red and Raman spectroscopy. A.

535.33.03

1489. The intensity of spectral lines produced in nonhomogeneous flames. A. C. KOLB AND E. R. STREED. *J. chem. Phys.*, **20**, 1872–8 (*Dec.*, 1952).

The emission and absorption of radiant energy in a nonhomogeneous flame is discussed. Multiple scattering is neglected and the solution of the basic one-dimensional equation of transfer is obtained in series form. The series is rapidly convergent and a first term approximation yields a simple formula for a flame source having a plane of symmetry which gives satisfactory agreement with experimentally determined nonlinear spectrochemical calibration curves. A.

535.33.03 : 536.46

1490. Quantitative studies of apparent rotational temperatures of OH in emission and absorption (spectral lines with Doppler contour). S. S. PENNER. *J. chem. Phys.*, **21**, 31–41 (*Jan.*, 1953).

Even if a Boltzmann distribution exists for the population of molecules in various energy levels, it is not possible to obtain a satisfactory interpretation of experimental data by the use of conventional procedures unless the product of maximum spectral absorption coefficient P_{max} and optical density X is

sufficiently small. Detailed calculations are presented which show that the experimental results, which suggest an anomalous rotational temperature for the $^2\Sigma$ state of OH in low pressure combustion flames, can be accounted for by using sufficiently large values for $P_{max}X$. Whether or not experimental data should be interpreted in this manner must be determined by auxiliary studies. Representative absorption studies for the determination of rotational temperatures in isothermal systems have been analysed for the P_1 branch, (0,0) band, $^2\Pi \rightarrow {}^2\Sigma$ transitions of OH at 3000°K. The calculations show that erroneous interpretation of experimental results occurs if the product $P_{max}X$ is not small compared to unity. Sample calculations for a blackbody light source show that the customary procedure for treating experimental results will permit adequate correlation of the data by straight lines up to relatively large values for $P_{max}X$. It is remarkable that the preceding statement remains true even under conditions in which emission data clearly indicate that $P_{max}X$ is no longer small compared to unity. Representative calculations to determine observable peak and total intensity ratios in emission for spectral lines with Doppler contour have been carried out for $^2\Sigma \rightarrow {}^2\Pi$ transitions, (0,0) band, P_1 branch of OH at 3000°K. The calculations show that the ratios of peak and total intensities are functions of the products of maximum absorption coefficients (P_{max}) and optical density (X) for the lines under study. Quantitative calculations have been carried out of apparent rotational temperatures in systems containing non-equilibrium distributions of OH at 3000°K and at 6000°K. The calculations on the P_1 branch, $^2\Sigma \rightarrow {}^2\Pi$ transitions, indicate that, in the absence of self-absorption, conventional plots showing discontinuities necessarily overestimate one and underestimate the other of the known temperatures of 3000°K and 6000°K. Quantitative calculations on the nature of distortions produced when an isothermal region at 3000°K is viewed through an isothermal region at 1500°K show that the presence of a non-isothermal field of view magnifies the distortion produced by self-absorption alone. On the basis of the noncontroversial quantitative calculations described for idealized systems, some speculations regarding the significance of reported flame temperature anomalies for OH are presented. A.

535.33.03 : 537.525.8

Infrared molecular emission excited in a glow discharge. *See Abstr.* 1663

535.33.07 : 535.421

1491. Double-passing a plane grating. D. H. Rank and T. A. Wiggins. Letter in *J. Opt. Soc. Amer.*, **42**, 983–4 (*Dec.*, 1952).

A Littrow plane grating spectrograph is arranged as a double-pass instrument. λ5461 Hg has been photographed, in the 4th and 5th orders double passed, with resolution at least equal to that in the 6th order single passed. R. W. FISH

535.33.07–15

1492. A simplified method of calibrating infra-red spectrometers. J. H. Towler and W. Guy. *J. sci. Instrum.*, **29**, 393–7 (*Dec.*, 1952).

The possibility of simplifying the calibration of rocksalt prism spectrometers with similar optical systems has been investigated and an accurate yet labour-saving method developed. The method depends upon the accurate determination of a limited number, say 10, of evenly spaced calibration points for a spectrometer to be calibrated, over the range 0·5 μ to 15 μ. The results are compared with a standard calibration table and a correction table or curve drawn up which enables the standard table to be entered for any reading. Theoretical aspects are discussed and the shape of a correction curve shown to be simple. A standard calibration table for a Grubb–Parsons rocksalt prism spectrometer at 25°C is given and the feasibility of the method has been demonstrated using results for a number of Grubb–Parsons and Perkin–Elmer rocksalt prism spectrometers. A.

535.33.07–15 : 535.825

1493. Infrared microspectroscopy. III. A capillary cell for liquids. E. R. Blout, M. Parrish, Jr, G. R. Bird, and M. J. Abbate. *J. Opt. Soc. Amer.*, **42**, 964–8 (*Dec.*, 1952).

For Pt II, see Abstr. 7667 (1951). Apparatus and methods are described for the determination of infrared spectral absorption of solutions containing about 1 gamma (10^{-6} gm) of solute. The absorption cell used is a piece of capillary tubing made of silver chloride with a central hole about 0·075 mm in diameter. The cells have lengths of 1 to 1·5 mm and are filled by means of a micropipette. A magnified image of the cell is then projected on the entrance slit of a spectrometer, and the spectral data are recorded. Results with typical organic compounds indicate that satisfactory spectral resolution may be obtained with this capillary cell. A.

535.332 : 535.337

1494. The Doppler effect and spectroscopic resolving powers. H. Kuhn. *Z. Phys.*, **133**, *No.* 1–2, 9–14 (1952) *In German.*

Gives a general discussion of experimental aspects of Doppler widths and makes reference to cooled discharge tubes, hollow cathode discharges, and molecular beam techniques. J. D. CRAGGS

535.337 : 539.153

1495. Effect of an electric field on the profile of the HI ($2^2P_0 - n^2D$) lines emitted in radiative transitions. C. Weniger and L. Herman. *C.R. Acad. Sci. [Paris]* **235**, 1020–2 (*Nov.* 3, 1952) *In French.*

Theoretical. It is pointed out that, in calculating the profile, one should take into account the process by which the electron has been brought to the excited state. In the example considered one obtains, in agreement with experiment, a higher intensity at the centre of the line than was given by previous theories. L. PINCHERLE

535.338 : 537.527.5

1496. On a structure in the continuous radiation of high pressure mercury vapour discharges. F. Rössler. *Z. Phys.*, **133**, *No.* 1–2, 80–93 (1952) *In German.*

Gives results of an experimental investigation of continuous radiation, especially between the wavelengths 4339 and 4916 Å, from a high pressure Hg arc. The data are discussed and it is suggested that possible causes of the radiation are recombination and molecular effects. J. D. CRAGGS

535.338–32

1497. Intensity measurements in the vacuum ultra-violet. K. WATANABE AND E. C. Y. INN. *J. Opt. Soc. Amer.*, **43**, 32–5 (*Jan.*, 1953).

Intensities of dispersed radiation in the region 500–300 Å were measured with a compensated thermocouple mounted at the exit slit of a one-meter, normal incidence, vacuum monochromator. With 1 mm slits (17 Å band width), He I at λ584 was found to be 0·025 microwatt over the exit slit. With a 1P21 tube coated with Na salicylate and using 50 micron slits, the relative intensities of the first four members of the principal series of He I at λ584, λ537, λ522 and λ516 were measured. The H_2 spectrum from 850 to 3000 Å was also obtained with the thermocouple. The relative quantum efficiency of Na salicylate was found to be constant in this spectral region and about 15% lower at λ584. Some of these measurements were made possible by a great increase of grating efficiency after an unintentional coating of the grating with a layer of evaporated Pt. A.

535.338.332

1498. On the fine structure of the helium triplets. J. BROCHARD, R. CHABBAL, H. CHANTREL AND P. JACQUINOT. *J. Phys. Radium*, **13**, 433–7 (*Oct.*, 1952) *In French.*

The fine structure of the 2^3P, 3^3P and 3^3D levels was measured by means of a photoelectric Fabry–Pérot interferometer at the temperature of liquid hydrogen. Errors in previous measurements due to self-absorption were revealed. Araki's theory (1937) generally accounts for the observed structures, though there are some deviations. L. PINCHERLE

535.338.333

1499. The isotope shift between RaD and the stable lead isotopes. P. BRIX, H. v. BUTTLAR, F. G. HOUTERMANS, AND H. KOPFERMANN. *Z. Phys.*, **133**, *No.* 1–2, 192–200 (1952) *In German.*

Fabry-Pérot measurements of the 4058 Å line of Pb I have yielded the isotope shift $\Delta\nu$ (Pb 208–210) = $(141 \pm 3)\times10^{-3}$ cm^{-1}. Hence $\Delta\nu$ (Pb 208–210)/$\Delta\nu$ (Pb 206–208) = $1{\cdot}74 \pm 0{\cdot}05$. It follows that there is a sudden change in the isotope shift at $N = 126$, analogous to that after $N = 82$ and, probably, $N = 50$. This sudden change is probably related to a greater increase of the radius of the nucleus. The chemical separation of RaD and the spectrographic apparatus used are described in some detail. F. LACHMAN

535.338.333

1500. Isotope displacements in the Gd I spectrum. P. BRIX AND H. D. ENGLER. *Z. Phys.*, **133**, *No.* 3, 362–9 (1952) *In German.*

The h.f.s. of 65 lines was measured with a Fabry–Pérot interferometer. Data on the isotope displacements for Gd^{158}–Gd^{160} are given for five electron configurations. The isotopes 156, 158 and 160 appear to be equidistant. Some conclusions are reached on the screening effect of the 4*f*- on the 5*s*-electrons. L. PINCHERLE

535.338.333

1501. The hyperfine structure of the Pb I line λ4058 Å. A. STEUDEL. *Z. Phys.*, **133**, *No.* 3, 438–42 (1952) *In German.*

A sample containing only the isotopes 206 and 208 was studied with a Fabry–Pérot interferometer. The position of the 207 lines was also measured on a sample of ordinary Pb. Results of various authors are discussed and the best values of the isotope displacements relative to 206 (in 10^{-3} cm^{-1}) are given as: 204, -73 ± 5; 207, 31 ± 2; 208, $81{\cdot}2 \pm 0{\cdot}5$. L. PINCHERLE

535.338.333

1502. Isotope shifts in thorium—Th 230 and Th 232. G. L. STUKENBROEKER AND J. R. MCNALLY, JR. *J. Opt. Soc. Amer.*, **43**, 36–41 (*Jan.*, 1953).

More than 250 spectrum shifts have been measured for lines of the neutral thorium atom (Th I) and of the singly-ionized thorium atom (Th II) in a sample of thorium containing 13% Th 230 (ionium). The observed isotope shifts between Th 230 and Th 232 spectrum lines range in magnitude up to 0·94 cm^{-1}. The Th 232 line in every case is to longer wavelength, and hence the Th 230 energy levels are more tightly bound than the corresponding levels of Th 232. A summary is given of isotope shift data. A.

535.338.4

1503. On the molecular spectra emitted by mercury vapour. H. TAKEYAMA. *J. Sci. Hiroshima Univ. A*, **15**, 235–62 (*Feb.*, 1952).

A detailed account of the production and measurement of bands ascribed to Hg_2 in the region 2500–5500 Å. The vibrational analyses of two systems, both with $\omega' \sim 120$; $\omega'' \sim 140$ cm^{-1}, and with $\nu_{0,0} = 19\,615$ and $22\,152$ cm^{-1}, is given. R. F. BARROW

535.338.4

1504. Intensities in band-systems of O_2 and O_2^+. M. E. PILLOW. Letter in *Proc. Phys. Soc.* [*London*] *A*, **65**, 858–9 (*Oct.*, 1952).

A comparison of observed and calculated intensities is given for the Schumann–Runge and Second Negative systems. R. F. BARROW

535.338.4

1505. Ultra-violet band system of strontium oxide (SrO). G. ALMKVIST AND A. LAGERQVIST. Letter in *Nature* [*London*] **170**, 885–6 (*Nov.* 22, 1952).

A rotational analysis shows that the bands of SrO in the region 3200–3700 Å arise from a $^1\Sigma - {}^1\Sigma$ transition with $B_0' \sim 0{\cdot}272$ cm^{-1}. The lower $^1\Sigma$ state is the lower state of the blue and infra-red systems. R. F. BARROW

535.338.4

1506. Emission of molecular complexes of nitro-compounds. R. FOSTER AND D. L. HAMMICK. Letter in *Nature* [*London*] **171**, 40 (*Jan.* 3, 1953).

535.338.4

1507. The electronic emission spectrum of $C^{13}O^{16}$. K. E. MCCULLOH AND G. GLOCKLER. *Phys. Rev.*, **89**, 145–7 (*Jan.* 1, 1953).

The part of the emission spectrum of $C^{13}O^{16}$ occurring between 1900 and 6500Å has been obtained in an uncondensed discharge under conditions of low current density. A rotational analysis of the 0–1, 0–2, 0–3, 0–4, 0–5 and 1–1Å bands has been made. The molecular constants derived therefrom agree closely with those calculated for $C^{13}O^{16}$ from spectroscopic data pertaining to $C^{12}O^{16}$. The behaviour, with respect to isotopic substitution, of the first vibrational

quantum in the $B^1\Sigma^+$ electronic state suggests the possibility of rapid convergence of the levels. In the 4th positive group of $C^{13}O^{16}$, 35 band heads have been measured, involving 9 v'' progressions and 12 v' progressions, each including at least 2 measured bands. Band origins calculated from these data agree closely with those represented by term formulae herein proposed. Vibrational constants for the ground electronic states of the two isotopic species, consistent with the theory of the isotope effect and with existing experimental data are, in cm^{-1},

	ω_e	$\omega_e\chi_e$	$\omega_e\gamma_e$
$C^{12}O^{16}$	2169·84	13·301	0·0123
$C^{13}O^{16}$	2121·47	12·715	0·0115

A.

535.338.4 : 551.594.51

1508. Excitation and duration of the "auroral afterglow" in nitrogen. G. CARIO AND U. STILLE. *Z. Phys.*, **133**, *No.* 1–2, 209–28 (1952) *In German.*

A description is given of the uncondensed discharge in N_2, first observed by Kaplan (1933). Discussion follows of the possible mechanisms required to produce the observed phenomena, viz. excitation, and destruction of molecular ions, and to account for the resultant intensity distribution in the band spectra. D. R. BARBER

535.343 : 541.57

1509. Spectroscopic study of the hydrogen bond in light and heavy trifluoroacetic and trichloroacetic acids. M.-L. JOSIEN AND N. FUSON. *C.R. Acad. Sci.* [*Paris*] **235**, 1025–7 (*Nov.* 3, 1952) *In French.*

In the spectra of these substances between 650 and 3600 cm^{-1}, the broad OH and OD bands corresponding to the associated molecules contain frequencies corresponding to the terms of an arithmetic progression. This agrees with Davies' and Evans' results for ordinary trichloroacetic acid [Abstr. 3769 (1952)] but not with those of Chulanovskii and Simova (1949). The differences of the progressions are roughly what one would expect in view of the D/H mass ratio. The periodicity can probably be explained on the basis of an extension of a hypothesis of Born's concerning different positions of equilibrium for the H atoms. A. J. TAYLOR

535.343–15

1510. The influence of temperature and state on infrared absorption spectra: methyl iodide. I. L. MADOR AND R. S. QUINN. *J. chem. Phys.*, **20**, 1837–42 (*Dec.*, 1952).

The spectra of methyl iodide were determined in the range 2 to 15 microns for the vapour at 25°C, the liquid at 25° and −50°C and the solid at −78°, −196° and −269°C. Differences were observed in frequencies, intensities and band shapes resulting from changes in state and temperature. There is band narrowing with reduction in temperature even in the solid. At the lowest temperatures, band splitting could be resolved in the degenerate bands as well as in the 1252 cm^{-1} nondegenerate fundamental. Several additional assignments are offered. A.

535.343–15 : 541.57

1511. Infrared spectroscopy and the character of chemical binding. R. MECKE. *J. chem. Phys.*, **20**, 1935–9 (*Dec.*, 1952).

The importance of the study of the intensities of vibrational bands yielding information concerning the charge distribution in chemical bonds is stressed. A method is developed for obtaining bond moments in the ground state by the extrapolation of the values calculated for the transition moments of the bond, these being obtained from intensity measurements on the fundamental and overtone bands. An empirical attempt is made to explain the total moment as the sum of an ionic, a polar and an inductive component. Agreement between experimental results and the empirical relations is good for OH and CH bonds in a large number of compounds. A.

535.343.2

1512. Hydrogen-like absorption spectrum of cuprous oxide. M. HAYASHI AND K. KATSUKI. *J. Phys. Soc. Japan*, **7**, 599–603 (*Nov.–Dec.*, 1952).

A new hydrogen-like absorption spectrum was found, additional to that found in previous work [Abstr. 1737 (1951)]. Thus there are two groups of hydrogen-like energy levels, of which the one previously found seems to be due to a self-trapped electron and the new one to an exciton. It leads to an estimate of 9·5 for the static dielectric constant of cuprous oxide. A.

535.343.2

1513. Absorption spectra of crystalline chlorophyll derivatives. E. RABINOWITCH, E. E. JACOBS, A. S. HOLT AND R. KROMHOUT. *Z. Phys.*, **133**, *No.* 1–2, 261–71 (1952) *In German.*

Absorption bands of ethylchlorophyllide show a gradual shift to the red (6600 → 7450Å and 4260 → 4500Å) with increasing crystal size, reaching constant positions when the crystal contains at least about 10^{10} molecules. The possibility of these shifts, and the smaller one found with chlorophyll *in vivo*, being due to resonance is discussed in general terms.

G. F. LOTHIAN

535.343.2 : 535.372

1514. The spectra of rubies. R. RITSCHL AND R. MÜLLER. *Z. Phys.*, **133**, *No.* 1–2, 237–43 (1952) *In German.*

The continuous absorption and the red fluorescence spectra of ruby are measured to determine their dependence on Cr content up to 100% Cr. A shift from red to green emission with Cr content is attributed to changes in the continuous absorption.

G. F. J. GARLICK

535.343.2 : 539.132

1515. Direct evidence for the $n \rightarrow \pi$ electronic transition of the nitroso-absorption. K. NAKAMOTO AND K. SUZUKI. Letter in *J. chem. Phys.*, **20**, 1971–2 (*Dec.*, 1952).

The absorption of linearly polarized light, parallel and perpendicular to the molecular axis, by crystalline *m*-nitronitrosobenzene, gives two bands, one in the visible (weak) and the other in the u.v. Consideration of the symmetry properties of the wavefunctions describing the ground and the three possible excited states resulting from one π–π and two n–π transitions (one from each of the lone pair systems of the NO and NO_2 groups) enables the direction of the moment of the allowed transitions to be determined. The relative displacements of the $\perp$ and $\parallel$ bands indicates that the u.v. and visible bands are associated with the π–π and one of the n–π transitions respectively.

H. H. GREENWOOD

535.343.2 : 548.7

1516. Vibrational structure of electronic transitions in single crystals of praseodymium and neodymium salts. A.-M. HELLWEGE AND K.-H. HELLWEGE. *Z. Phys.*, **133**, *No.* 1–2, 174–91 (1952) *In German.*

The absorption spectrum of the trigonal salts $X_2Zn_3(NO_3)_{12}.24H_2O$, (X = Pr or Nd), was taken at 14°K in polarized light. The transitions $^3H_4 \rightarrow {}^3P_0$ and $^3H_4 \rightarrow {}^3P_1$ were considered: inter- as well as intramolecular vibrations were observed. The possible types of vibrations are derived quantum mechanically with neglect of the interaction between cells. The symmetry of a unit cell is D_{3d}, that of the neighbourhood of the Pr or Nd ions only C_{3v}. The frequencies of the lattice vibrations are found from the line distances in the spectrum, and their symmetry types are determined from the polarization. A considerable number of vibrations are identified. The 12 equivalent NO_3 ions in a cell form a system with eigenvibrations, which originate from the vibrations of the free ions, forming eight different levels, of which four are degenerate, because of resonance. A. J. TAYLOR

535.343.2/.3–15 : 535.375.5

1517. The molecular spectra of condensed oxygen and the O_4 molecule. A. L. SMITH AND H. L. JOHNSTON. Letter in *J. chem. Phys.*, **20**, 1972–3 (*Dec.*, 1952).

The i.r. and Raman spectra of liquid and solid oxygen and liquid oxygen-nitrogen mixtures are discussed. For the i.r. spectra, the curves of absorption coefficient v. frequency of vibration exhibit an anomaly which is attributed to the presence of O_4 molecules. G. I. W. LLEWELYN

535.343.2–14 : 537.311.33

New method for the study, by high frequency spectroscopy, of defects in the structure of the semiconductor ZnO. *See Abstr.* 1640

535.343.2–15

1518. Infrared studies of mixed crystals: naphthalene-d_8 in naphthalene. W. B. PERSON AND G. C. PIMENTEL. *J. chem. Phys.*, **20**, 1913–15 (*Dec.*, 1952).

Polarized infrared studies in the region 615 to 645 cm^{-1} have been made using dilute solid solutions of naphthalene-d_8 in naphthalene. The *ab* plane at normal incidence was studied with light polarized either parallel or perpendicular to the *b* axis. The mole fraction of $C_{10}D_8$ was varied from 0·10 to 0·30. The dichroic splitting of the 632-cm^{-1} band observed in pure $C_{10}D_8$ decreases with concentration. This is the splitting predicted in the factor group analysis and is attributed to intermolecular coupling. This is a further indication that the magnitude of this splitting in molecular crystals such as $C_{10}H_8$ is only a few cm^{-1}, and that the "oriented gas" model is applicable. Using this model, the 632-cm^{-1} band of $C_{10}D_8$ is assigned as a single fundamental of the B_{1u} or B_{3u} class. A.

535.343.2–15

1519. Study of the structure of quartz, cristobalite, and vitreous silica by reflection in infrared. I. SIMON AND H. O. MCMAHON. *J. chem. Phys.*, **21**, 23–30 (*Jan.*, 1953).

Infrared spectra of α- and β-quartz, α- and β-cristobalite and vitreous silica were studied by the reflection method using natural and polarized radiation in the 700 to 1400 cm^{-1} wave number interval. By measuring the reflecting powers at two different angles of incidence, the indices of refraction and extinction were obtained and the absorption bands could be correctly located, sometimes at variance with the existing data, based on reflection maxima alone. The strong band at 1055 cm^{-1} in α-quartz and at 1095 cm^{-1} in α-cristobalite and vitreous silica can be assigned as a valence stretching $\overleftarrow{Si}—\overrightarrow{O}—\overleftarrow{Si}$ vibration. Other observed bands are consistent with the already existing assignments. The effect of temperature on the total intensity and width of the bands was studied in a temperature interval between 4°K and 880°K. A.

535.343.2–32

1520. Absorption spectrum of solid nitrous oxide in the Schumann region. J. ROMAND AND J. GRANIER-MAYENCE. *C.R. Acad. Sci.* [*Paris*] **235**, 1023–5 (*Nov.* 3, 1952) *In French.*

At 60°K, this spectrum has a maximum of 1780Å, corresponding to the B band of gaseous N_2O (1830Å). This absorption has not been reported for the liquid. It is supposed that the displacement is due to modification of excited vibrational levels by the formation of the solid, the ground level not being affected. Further experiments are proposed, at liquid hydrogen temperature. A. J. TAYLOR

535.343.3/.4–15

1521. Substituted methanes. XII. Infrared spectral data for deuterotrichlormethane. R. B. BERNSTEIN, A. A. GORDUS AND F. F. CLEVELAND. Letter in *J. chem. Phys.*, **20**, 1979 (*Dec.*, 1952).

For Pt XI, see Abstr. 1805 (1953).

535.343.3

1522. The solution absorption spectra of americium (III), (V), and (VI). S. E. STEPHANOU, J. P. NIGON AND R. A. PENNEMAN. *J. chem. Phys.*, **21**, 42–5 (*Jan.*, 1953).

Detailed absorption spectra of Am(III), (V), (VI) and Eu(III) in perchloric acid were obtained over the range 200–800 mμ using the Cary Recording Spectrophotometer. Molecular extinction coefficients obtained from the average of several determinations are given for each absorption peak of the americium species. No vibrational fine structure similar to that reported for U(VI), Np(V), Np(VI) and Pu(VI) was found in the visible and ultraviolet spectra of Am(V) and (VI). This fine structure has been interpreted as arising from symmetrical metal-oxygen vibration in ions of the type MO_2^+ and MO_2^{++}. A.

535.343.3 : 535.372

1523. The Franck–Condon principle in spectra of associated dyes. G. SCHEIBE AND V. ZANKER. *Z. Phys.*, **133**, *No.* 1–2, 244–9 (1952) *In German.*

Most saltlike dyestuffs show a characteristic absorption spectrum: one strong band and a few weaker bands at about equal intervals of 1400 cm^{-1}. These are vibration bands. The minima of the potential curves of the ground- and excited states lie more or less straight above each other. Similar conclusions can be drawn from the emission spectrum of

fluorescent dyes. At higher concentrations association of the molecules occurs and the intensities of the vibration bands change considerably in the absorption as well as in the fluorescence spectra. In absorption spectra the high aggregates cannot be identified, but the emission shows them clearly. These bands can be explained by the Franck–Condon principle. The minima of the potential curves of the associated compounds are shifted, and in the excited states the curves are flatter than in the corresponding states of the monomer. There also occurs a long-wave group of bands in the emission spectrum, which depends upon concentration. The phosphorescence band originates at a metastable state with a considerable lifetime, so that it is possible to excite a big number of molecules to this state. These states are different for the various complexes, so that the transitions depend upon concentration. The mechanism of this transition is compared with that of anthracene, which occurs via a di-radical. The Franck–Condon principle can also be applied to the two bands (one forbidden and one normal) which lie near each other in benzene, naphthalene and anthracene. A. J. TAYLOR

535.343.3–14

1524. Measurements on the microwave spectra of methyl alcohol and nitromethane. G. ERLANDSSON. *Ark. Fys.*, **6**, *Paper* 7, 69–71 (1952).

Tests have been made within the range 16·3–25·7 Mc/s using a Stark effect modulation microwave spectrometer and an absorption cell 3 m long consisting of a 3-cm waveguide with a central steel electrode. Sine wave modulation is used with a maximum field intensity of 600 V/cm, the receiver being a spectrum amplifier tuned to the modulation frequency of 100 kc/s. With methyl alcohol, ten lines were found within the range 16·3–20·0 kMc/s, only three of which have been reported previously. The nitromethane tests gave 94 lines, compared with 15 reported previously. Where comparison with other work was possible, agreement was good.

A. C. WHIFFIN

535.343.32–15 : 535.375.55

1525. Raman and infrared spectral data and assignments for dimethyldiacetylene. S. M. FERIGLE, F. F. CLEVELAND AND A. G. MEISTER. *J. chem. Phys.*, **20**, 1928–31 (*Dec.*, 1952).

Raman displacements and quantitative depolarization factors, and wave numbers for the infrared bands in the KBr region have been obtained for dimethyldiacetylene in CCl_4 and benzene solutions. Since the results of the present work are inconsistent with some of the previous assignments, these have been changed. In particular, the line at 475 cm^{-1}, which was previously considered an A_1-type fundamental vibration, is now proved to be depolarized and is assigned as an E-type fundamental. Consistently with this change, the assignment of the 644 cm^{-1} line of diacetylene as a bending mode is considered. The previous assignments of both of these lines were the cause of the conflicting data existing in the literature between the bond length and the stretching potential constant of the central bond in the structure —C≡C—C≡C—. A.

535.343.4

1526. Absorption spectra of gaseous radicals in thermal equilibrium. K. WIELAND. *Z. Phys.*, **133**, *No.* 1–2, 229–36 (1952) *In German.*

I. Diatomic radicals. A table is given of all possible diatomic radicals. The absorption method can be used below 1200°c: (A) for light radicals: OH, CN, BH, NH, CH, CF using the stable molecules H_2O, C_2N_2, B_2H_6, NH_3, CH_4, CF_4, whose absorption is in the far u.v. or in the Schumann-region; (B) with special precautions absorption spectra of metal halogenides MX can be measured. Conditions are given for PbX, HgX, MeX (Me: alkaline earth), MnX, AlX; (C) metal hydrides cannot be measured by heating the stable compounds, but occur on heating the metals in a hydrogen atmosphere; (D) metal oxides can seldom be observed under 1200°c.

II. Polyatomic radicals. Their number is small; the emission and absorption spectra of a few are known, but none in thermal equilibrium. It should be possible to study the absorption spectra of a number of polyatomic radicals, especially hydrides and halogenides. C. TURNER

535.343.4

1527. Absorption spectra of SH and SD produced by flash photolysis of H_2S and D_2S. D. A. RAMSAY. *J. chem. Phys.*, **20**, 1920–7 (*Dec.*, 1952).

H_2S and D_2S were irradiated in a flash photolysis apparatus, and the absorption spectra of the products were photographed within 1 msec of the photolysis flash using the second order of a 21 ft grating spectrograph. The (0, 0) and (1, 0) bands of SH and SD were observed and analysed. The following molecular constants for SH were obtained: $^2\Sigma^+$ state: $B'_e = 8{\cdot}538_1\ cm^{-1}$, $\alpha'_e = 0{\cdot}509_1\ cm^{-1}$, $r'_e = 1{\cdot}421_5$Å, $\nu_{00} = 30\,662{\cdot}4_2\ cm^{-1}$, $\Delta G'_{\frac{1}{2}} = 1784{\cdot}6_3\ cm^{-1}$, $\gamma_0 = 0{\cdot}313\ cm^{-1}$. $^2\Pi$ state: $B'' = 9{\cdot}461_1\ cm^{-1}$, $r''_0 = 1{\cdot}350_3$Å, $A = -376{\cdot}9_6\ cm^{-1}$. The rotational lines of the (1, 0) SH band were observed to be diffuse, indicating a predissociation in the first vibrational level of the $^2\Sigma^+$ state. This establishes an upper limit of 92·7 kcal and a lower limit of 66·3 kcal for the ground state dissociation energy of SH. A.

535.343.4–14

1528. The microwave spectrum of vinylacetylene. H. W. MORGAN AND J. H. GOLDSTEIN. Letter in *J. chem. Phys.*, **20**, 1981 (*Dec.*, 1952).

Five lines of the $J_{2\to3}$ grouping near 27 000 Mc/s are observed and assigned. D. H. WHIFFEN

535.343.4–15

1529. Measurement of band intensities of infra-red absorption in vibration-rotation spectra. M. L. GRENIER-BESSON AND G. AMAT. *J. Phys. Radium*, **13**, 451–7 (*Oct.*, 1952) *In French.*

Experimental conditions and correction for errors are given for the band of methyl iodide at 1·6 μ.

D. H. WHIFFEN

535.343.4–15

1530. The infrared spectrum of chlorine dioxide. A. H. NIELSEN AND P. J. H. WOLTZ. *J. chem. Phys.*, **20**, 1878–83 (*Dec.*, 1952).

This has been reinvestigated from 2–40 μ. Several new bands have been discovered, among them the

bending frequency ν_2 at 445 cm^{-1}. This band has the doublet character required if the molecular model is to be an obtuse triangle in accord with electron diffraction experiments. Three bands, ν_1, ν_2 and $2\nu_1$, were resolved with prism and grating methods, and the spacing of the Q lines was found to be about 3·0 cm^{-1}. An $A''-B''$ value of 1·413 cm^{-1} was obtained from the analysis of ν_2, and this value also is in excellent agreement with the electron diffraction measurements. Moments of inertia computed from the r(Cl–O) = 1·49Å and 2α (apex angle) = 118·5° obtained from a combination of electron diffraction and infrared data are $I_A = 16{\cdot}09\times10^{-40}$ g cm^2, $I_B = 86{\cdot}34\times10^{-40}$ g cm^2 and $I_C = 102{\cdot}43\times10^{-40}$, g cm^2. A band which cannot be ascribed to an impurity was found at 290 cm^{-1}. The possibility that this band results from polymerization of ClO_2 is suggested. A.

535.343.4–15

1531. Infrared spectra of H_2O and CO_2 at 500°C. J. H. Taylor, W. S. Benedict and J. Strong. *J. chem. Phys.*, **20**, 1884–98 (*Dec.*, 1952).

A porcelain-lined absorption cell of the Pfund type is described, in which 3 m of gas may be heated to temperatures above 500°C. The spectra of air at atmospheric pressure containing varying amounts of H_2O and CO_2 have been obtained in this cell between 2·4–15 μ with a prism spectrometer, and between 13–25 μ with a grating spectrometer giving spectral resolution of about 2 cm^{-1}. A number of new lines in the pure rotation spectrum and the ν_2 vibration of H_2O, originating from levels of high energy, have been observed and classified. New CO_2 bands in the regions of 11–20 μ and 5 μ have also been observed, originating from levels as high as $5\nu_2$, and leading to improved values of higher-quanta levels of ν_2 and vibrational constants for this molecule. A.

535.343.4–15 : 535.375.5

1532. Infrared and Raman spectra of fluorinated ethylenes. V. Hexafluoropropene. J. R. Nielsen, H. H. Claassen and D. C. Smith. *J. chem. Phys.*, **20**, 1916–19 (*Dec.*, 1952).

For Pt IV, see Abstr. 6402 (1952). The infrared absorption spectrum of gaseous $CF_2:CF–CF_3$ has been obtained in the region from 2 to 38 μ, with the aid of LiF, NaCl, KBr and KRS–5 prisms. The Raman spectrum of both the gaseous and the liquid phase has been photographed with a three-prism glass spectrograph of linear dispersion 15 Å mm at 4358Å, and depolarization ratios have been measured for the stronger bands. A complete assignment of fundamental vibrational frequencies is given, although 4 of the 21 fundamentals must be regarded as uncertain. The spectra are interpreted in detail. A.

535.343.4–31

1533. Absorption studies of the vapors of the three isomeric picolines in the near ultraviolet. J. H. Rush and H. Sponer. *J. chem. Phys.*, **20**, 1847–62 (*Dec.*, 1952).

Studies of the near u.v. absorption spectra of α-, β- and γ-picoline vapour have been made in low and medium dispersion. Conclusive evidence is found for two electronic transitions in the vicinities of 35 500 and 38 500 cm^{-1}. The former transition is interpreted as an allowed $A_1–B_2$ transition resulting from the excitation of an sp^2 non-bonding electron of the nitrogen atom into the first unfilled π orbital of the ring. The latter transition is considered an allowed $A_1–B_1$ transition resulting from the excitation of a π ring electron. The $A_1–B_2$ system exhibits narrow headless bands similar to the first absorption bands in pyridine. It is of weak intensity comparable to that of the forbidden $A_{1g}–B_{2u}$ transition in benzene. The $A_1–B_1$ system, which is much stronger, consists of broad diffuse bands. There is evidence that this system may be overlapped by another transition in β-picoline. A.

535.343.4–31

1534. The near ultraviolet absorption spectra of 1,4 bis-(trifluoromethyl)benzene and 1,3,5 tris-(trifluoromethyl)benzene. C. D. Cooper and F. W. Noegel. *J. chem. Phys.*, **20**, 1903–7 (*Dec.*, 1952).

The vapour absorption spectra of 1,4 $C_6H_4(CF_3)_2$ and 1,3,5 $C_6H_3(CF_3)_3$ have been obtained with a Bausch and Lomb Littrow spectrograph. Corresponding solution spectra were obtained with a Beckman DU spectrophotometer. Oscillator strengths f were found to be $12{\cdot}0\times10^{-3}$ and $2{\cdot}1\times10^{-3}$ for the *para* di- and tri-substituted compounds, respectively. Both of the vapour spectra are diffuse with the bands of the 1,3,5 compound showing extreme diffuseness. The O,O band of the 1,4 bis-(trifluoromethyl)benzene is located at 37 460 cm^{-1}. Progressions and combinations involving the upper state frequencies of 210, 770 and 1020 cm^{-1} are observed. The 210 and 1020 values are correlated with the observed ground state values of 240 and 1070 cm^{-1}, and these are associated with totally symmetric vibrations. The 1,3,5 tris-(trifluoromethyl)benzene spectrum is interpreted as a "forbidden" one and the bands at 38 670 and 38 070 cm^{-1} are assigned as 0,1 and 1,0 bands, respectively. Rough calculations show the 0,0 band to be shifted about 300 cm^{-1} toward the violet relative to the benzene spectrum. A.

535.343.4–32

1535. Absorption coefficients of gases in the vacuum ultraviolet. K. Watanabe, E. C. Y. Inn and M. Zelikoff. Letter in *J. chem. Phys.*, **20**, 1969–70 (*Dec.*, 1952).

Photoelectric measurements on O_2 and CO_2 (λ : 1200–1700Å) do not everywhere agree with published photographic measurements. G. F. Lothian

535.345

1536. Absolute optical absorption from diffuse reflectance. P. D. Johnson. *J. Opt. Soc. Amer.*, **42**, 978–81 (*Dec.*, 1952).

An equation relating the diffuse reflectance of crystalline powders to particle size, index of refraction and absolute optical absorption coefficient is derived. Absorption spectra calculated by means of this equation from diffuse reflectance of KCl : Tl, KBr : Tl, and didymium glass are shown to be in satisfactory agreement with absolute absorption measurements on clear crystals of the same materials. A.

535.345 : 535.371

1537. Measurement of the ultraviolet absorption of fluorescent powders by their diffuse reflexion. Z. Bodó. *Acta phys. Hungar.*, **2**, *No.* 1, 5–12 (1952).

The diffuse reflection of powders of homogeneous

grain sizes gave suitable help in the determination of the absorption coefficient of several fluorescent powders at 2537Å and 3650Å excitation. For willemites containing Mn and Fe it was found that the absorption coefficient for 2537Å is a linear function of both the Mn and Fe concentration, and the absorption of Fe is approx. twice as great as that of Mn. 3650Å is absorbed substantially only by Fe. For halophosphates containing Sb and Mn it was found that the absorption coefficient for 2537Å is a linear function of the Sb content; the Mn is non-absorbing. 3650Å is absorbed only slightly by Sb and more strongly by the Mn. The absorption coefficient of the host lattice was slight in both cases. For willemites and halophosphates the absorption coefficient was found to be temperature independent. For cadmium borate activated by manganese it changed, however, between −100°C and +300°C by a factor of ten. A.

535.345 : 541.15

1538. Enhancement of X-ray induced absorption bands in alkaline earth compounds. J. H. Schulman, R. J. Ginther and R. D. Kirk. *J. chem. Phys.*, **20**, 1966–7 (*Dec.*, 1952).

It is deduced that the incorporation of monovalent positive ion impurities in alkaline earth salts should increase the discoloration of these compounds by ionizing radiations. This deduction is confirmed experimentally with alkaline earth fluorides and strontium sulphate "sensitized" with alkali-ion impurities. As predicted, M^{+3}-ion and X^{-}-ion impurities poison the sensitizing effect of the M^{+1}-ion impurities. A.

535.345.6 : 771.1

1539. Coloured "Perspex" for darkroom lights. L. A. T. Ballard. Letter in *Nature* [*London*] **170**, 840–1 (*Nov.* 15, 1952).

Red 400 and Amber 300 Perspex have been used in place of glass to obtain weak phototropically inactive light in a physiological darkroom in which plants and cultures may be grown with minimum disturbance from light. Transmission data over the range 5260–7000Å are given. R. W. FISH

535.37

1540. Photoluminescence of a sublimate phosphor of silver iodide. K. V. Shalimova and N. S. Mendakov. *Dokl. Akad. Nauk SSSR*, **82**, *No.* 4, 575–8 (1952) *In Russian.*

535.371

1541. Copper-activated zinc sulphide phosphors with new emission characteristics. H. C. Froelich. Letter in *J. Opt. Soc. Amer.*, **42**, 982 (*Dec.*, 1952).

ZnS phosphors prepared by heating very pure ZnS precipitate with large copper additions in a pure H_2S atmosphere at 1100°C show emission bands in the yellow and red regions in addition to the usual blue and green bands. The limit of copper concentration is found to be 0·1–0·01% unless greater concentrations of Al or other trivalent elements are present when the limit increases to more than 0·5%. The component parts of the new emission bands show different phosphorescence characteristics.

G. F. J. GARLICK

535.371

1542. Luminescence behaviour in tritium oxide. W. M. Jones. Letter in *J. chem. Phys.*, **20**, 1974 (*Dec.*, 1952).

The visible luminescence of a T_2O ice crystal is observed. When the water or ice is cooled to 76°K the luminescence intensity first rises and then falls with time over a period of hours with little spectral change. No thermal glow is observed on warming.

G. F. J. GARLICK

535.371

1543. Light yield and destruction of phosphors by electron and ion bombardment. W. Hanle and K. H. Rau. *Z. Phys.*, **133**, *No.* 1–2, 297–308 (1952) *In German.*

The light yield of ZnS–Ag (10^{-3}%), Zn_2SiO_4–Mn (0·5%) and $MgWO_4$ phosphors is examined during bombardment by H_2, He, Ne, A and Xe ions and by electrons respectively. Dependence of yield on ion energy is very small and independent of ion current. The light yield decreases with ion dosage and with ionic mass. ZnS–Ag is 10 times more susceptible to destruction than the other phosphors.

G. F. J. GARLICK

535.371

1544. Luminescence of willemites containing manganese and iron. E. Nagy and Z. Bodó. *Acta phys. Hungar.*, **2**, *No.* 3, 175–82 (1952).

The poisoning effect of iron is caused by several agencies. It is shown that the iron has a concurrent absorption for 2537Å excitation and in addition has some absorption for the emitted manganese luminescence. Both effects are, however, inadequate to explain entirely the poisoning effect. The iron is also capable of prohibiting the radiative transition of the excitation energy absorbed previously on the manganese itself. A formula was derived to account for the brightness of manganese and iron containing willemites at low temperatures. The agreement between measured and calculated values is quite satisfactory. A.

535.371

1545. Luminescence and trapping in phosphors containing gallium. R. H. Bube and S. Larach. *J. chem. Phys.*, **21**, 5–11 (*Jan.*, 1953).

A study was made of the effects of Ga impurity on the luminescence emission and trapping in phosphors with O-dominated host crystals and in phosphors with zinc sulphide host crystal. Ga acts (1) as an intensifier for host-crystal emissions in zinc silicate, magnesium silicate and zinc sulphide phosphors; (2) as an originative activator in zinc germanate phosphor; (3) as a poison for emissions resulting from manganese activator in silicate and germanate phosphors, and for emissions caused by Cu and Mn in zinc sulphide phosphors for cathode-ray excitation; (4) as a sensitizer for emissions resulting from Cu and Mn in zinc sulphide phosphors for ultraviolet excitation; (5) as a trapping agent in zinc silicate, magnesium silicate, zinc germanate and zinc sulphide; (6) as a trapping poison in beryllium silicate phosphors. Evidence is found for a correlation between types of emission centres and trapping centres in silicate and germanate phosphors. Results on intensification indicate that

intensifier activators are effective in increasing the intensity of host-crystal emissions by introducing crystal defects of the same type as those formed by random thermal processes in the preparation of the phosphor. A.

535.371 : 537.311.32

1546. On the electrical conductivity accompanying the phosphorescence of cadmium sulphide crystals. I. Broser and R. Warminsky. *Z. Phys.*, **133**, *No.* 3, 340–61 (1952) *In German.*

The influence of electron traps on the conductivity and luminescence of well activated CdS crystals is discussed in terms of the band model. Experiments are made to determine the decay of phosphorescence and corresponding decay of conductivity.

G. F. J. GARLICK

535.371 : 537.312.5

1547. Luminescence and photoconductivity in cadmium sulfide at the absorption edge. C. C. Klick. *Phys. Rev.*, **89**, 274–7 (*Jan.* 1, 1953).

Measurements of optical transmission, photoconductive response, luminescent edge emission and excitation spectrum for edge emission have been made on single crystal specimens of CdS at 77°K and 4°K. At the lowest temperature there is an energy gap of more than 0·1 eV between the absorption edge and the onset of emission. Coupled with information from the emission spectrum and the i.r. properties of CdS, this observation suggests that edge emission in this material may occur at a special centre and not be characteristic of the pure lattice. A.

535.372 : 537.583

1548. Luminescence and thermionic emission of barium oxide. V. L. Stout. *Phys. Rev.*, **89**, 310–14 (*Jan.* 1, 1953).

The cathodoluminescent spectrum of BaO samples has been studied as a function of the state of thermionic activity and the temperature of the samples. In order to conduct these measurements a vacuum tube was designed which allowed a sealed-off oxide sample to be studied at temperatures both above and below room temperature. Two of the six luminescent bands identified were found to vary in intensity as the thermionic emission of the sample changed. A luminescent band at 345 mμ increased in intensity with increasing thermionic activity; a luminescent band at 465 mμ decreased with increasing thermionic activity. The peak intensity of both bands was found to vary inversely with temperature. Speculations concerning possible luminescence mechanisms are presented. A.

535.373.3 : 621.385.832

1549. New phosphors for flying-spot cathode-ray tubes. A. Bril and H. A. Klasens. *Philips Res. Rep.*, **7**, 421–30 (*Dec.*, 1952).

The decay rates of a great number of phosphors under cathode-ray excitation have been determined. Ce-activated phosphors are the best for flying-spot c.r.t.'s used for black-and-white television. Of these phosphors $2CaO.Al_2O_3.SiO_2$–Ce was selected as the best phosphor in combination with glasses not blackening with soft X-rays or cathode-ray bombardment. Bismuth-activated phosphors are suitable as a red component in flying-spot cathode-ray tubes for colour television. A suitable phosphor for U.V. flying-spot microscopy is ZrP_2O_7. A.

535.375.5 : 532.7

1550. The Raman spectrum and structure of nitric acid and its aqueous solutions. H. Renner and O. Theimer. *Acta phys. Austriaca*, **6**, *No.* 1, 78–90 (1952) *In German.*

Experiments conducted in the concentration range from 0·87 to 24 mole/litre have shown that the frequencies, molar intensities and degrees of depolarization of Raman lines in the HNO_3–H_2O system are independent of concentration. The spectroscopic properties of this system can be explained if it is assumed that it contains the proton complexes of both the nitrate ion ($NO_3^-.nH^+$) and the pseudo-acid ($HNO_3.nH^+$), where n is 0, 1, 2 or 3. The mole fractions of the two groups (i.e. the nitrate ion and pseudo-acid groups) and the dissociation constant K of HNO_3 can be determined from the Raman line intensity. The lower limit for K is *c.* 1·7. It is very difficult to estimate the considerable errors unavoidable in the determination of the mole fractions and K.

F. LACHMAN

535.375.5 : 536.7 : 539.132

1551. The Raman spectrum, structure, force constants, and thermodynamic properties of bromine pentafluoride. C. V. Stephenson and E. A. Jones. *J. chem. Phys.*, **20**, 1830–3 (*Dec.*, 1952).

A Raman tube made of the plastic polychlorotrifluoroethylene was used. A method has been developed for making polarization measurements when Raman tubes constructed of this plastic are used. The spectrum of BrF_5 has been correlated with a tetragonal pyramid configuration with symmetry C_{4v}. Force constants were calculated using the Wilson FG Matrix method. The thermodynamic functions for BrF_5 were calculated for temperatures ranging from 313·7°K to 1500°K, using the rigid rotator, harmonic oscillator approximation. A.

535.375.55

1552. On the Raman spectra of *p*-diphenylbenzene in various solutions. S. K. Mukerji and B. Lal. *Nuovo Cimento*, **9**, 413–20 (*May*, 1952).

The Raman spectra of *p*-diphenylbenzene have been investigated in solutions of CS_2, chloroform, CCl_4, ethyl alcohol, ether and acetone respectively. The Raman frequencies obtained in the various solutions of the substance are compared with one another and with those obtained in the solid and molten states. It has been observed that some Raman lines are not present in all the solutions and that some have undergone changes of intensity in the various solutions. The results obtained in the various solutions have been compared and the changes of frequencies have been discussed. A.

535.376

1553. The multiple emission bands in zinc cadmium sulfide phosphors. E. B. Fehr, A. I. Friedman, F. J. Studer and G. R. Fonda. *J. Opt. Soc. Amer.*, **42**, 917–22 (*Dec.*, 1952).

Unexpected emission bands have been observed for ZnCdS.Ag high in cadmium. With high Ag, the

main emission band under cathode-ray-excitation at 10 kV appeared to be shifted to shorter wavelength on increase in current density. Under ultraviolet excitation at −196°C, the apparent shift was resolved into two emission bands, one of which corresponded to the new band that appeared under cathode rays; the other, to the normal band of the unactivated phosphor. With low Ag, edge emission bands appeared under high current-density cathode rays and sodium bands under ultraviolet at −196°C. A.

535.376 : 537.311.33 : 548.7

1554. Light emission produced by current injected into a green silicon-carbide crystal. K. Lehovec, C. A. Accardo and E. Jamgochian. *Phys. Rev.*, **89**, 20–5 (*Jan.* 1, 1953).

Deals with the light emission, which arises from the passage of a current in the forward direction over a *p-n*-barrier in a transparent ("pure") silicon-carbide crystal. The results differ from previous results obtained on a dark blue (impure) silicon carbide crystal in several respects: The spectral distribution of light emission is found to be independent of current and temperature. Both the efficiency of light emission and the decay constant of light emission increase exponentially with decreasing temperature. This is explained by a non-radiative transition of excited electrons. In a dark blue (impure) silicon carbide crystal, the resistances in series with the *p-n*-barrier were largely eliminated, and light emission at a voltage of the same magnitude as $h\nu/e$, was observed. A.

535.376 : 621.385.832

1555. Intrinsic efficiencies of phosphors under cathode-ray excitation. A. Bril and H. A. Klasens. *Philips Res. Rep.*, **7**, 401–20 (*Dec.*, 1952).

The intrinsic efficiencies of phosphors and their voltage and temperature dependence were measured with cathode-ray excitation in a demountable tube. The light outputs of thin layers of phosphors settled on glass were also determined. The light output at the glass side goes through a maximum with increasing layer thickness. For sulphide mixtures the maximum light output at the glass side was found to be only 30% of that of a thick layer at the gun side. Further losses of light occur due to settling and current saturation. As a result only 25% of the total light that can be obtained from a phosphor is radiated from the sulphide screen of a c.r.t. The value of the scattering and absorption coefficients were determined for sulphide and silicate screens using the formulae of Hamaker. Measurements on aluminized screens showed that the maximum gain of 2·5 to 3 which can be reached theoretically is not obtained because of light absorption in the aluminium layer. A.

535.393 : 537.311.62

1556. Optical and infrared reflectivity of metals at low temperatures. T. Holstein. Letter in *Phys. Rev.*, **88**, 1427 (*Dec.* 15, 1952).

An approximate formulation of the theory of the anomalous skin effect [Abstr. 1032 (1948)] for the optical region. The calculated absorptivity assuming diffuse reflection of the electrons at the metallic surface is much greater than the specular absorptivity, and is in rough agreement with recent experimental results [Abstr. 6408 (1952)]. E. H. Sondheimer

535.393–15

1557. The reflectivity of metals in the infra-red. R. B. Dingle. Letter in *Physica*, **18**, 985–8 (*Nov.*, 1952).

It is shown that if electrons are diffusely scattered at the surface of a metal, the anomalous skin effect persists at high frequencies, and the absorptivity in the near infra-red then attains a limit $1 + \frac{1}{4}(3\alpha/\omega\tau)^{\frac{1}{2}}$ times that predicted by classical (+relaxation) theory, where $\alpha = \frac{3}{2}l^2/\delta^2$, δ is the ordinary low-frequency skin depth, l the electronic mean free path, τ the relaxation time and $\omega = 2\pi \times$ frequency. The factor is always significantly different from unity for good conductors, especially at low temperatures, and agreement between theory and experiment is greatly improved by taking it into account. R. B. Dingle

535.417 : 531.715.1

1558. The limit of accuracy in the measurement of the thickness of a thin film using the Köster interference double prism. U. Zorll. *Optik*, **9**, *No.* 10, 449–55 (1952) *In German.*

An arrangement permitting the application of photometric methods is described. Fringe width is narrowed by multi-photographic copying and this permits an accurate measurement of fringe separation. Three photometric methods of evaluating displacements are described. The method permits the measurement of the thickness of deposited thin films. A square centimetre film can be measured with the thickness down to about 20 mμ. S. Tolansky

535.417 : 539.211

1559. Application of multiple-beam interferometry to the study of surface polish. O. S. Heavens. *Lab. Pract.*, **1**, 351–3 (*Nov.*, 1952).

It is shown how the method of studying surface topography by multiple-beam interferometry may be applied to the examination of glass surfaces under the action of polishing. The smoothness of a well-polished optical surface is compared with that of a crystal cleavage face and an estimate of the size of irregularities made. A.

535.421 : 535.417

1560. Interferometer action of a parallel pair of wire gratings. J. P. Casey, Jr and E. A. Lewis. *J. Opt. Soc. Amer.*, **42**, 971–7 (*Dec.*, 1952).

The transmission of electromagnetic waves by a pair of wire gratings is treated as a boundary value problem, including oblique incidence, arbitrary separation between gratings, and ohmic losses. The electric vector is taken parallel to the wires; the wavelength is greater than twice the grating constant and much larger than the wire radius. It is found that, even when the gratings are quite close together, each grating can be regarded as a continuous, partially reflecting surface. On this basis, the band-pass characteristics are described in detail. The relative merits of gratings and thin conducting films are discussed. In a numerical example, it is shown that although the resolving power is the same as with a pair of thin metallic films of the same reflectivity and separation,

the calculated peak transmission of the grating is about 8000 times larger. A.

535.43

1561. Additional light scattering functions for spherical particles of refractive index 2. M. KERKER AND H. E. PERLEE. *J. Opt. Soc. Amer.*, **43**, 49–50 (*Jan.*, 1953).

Additional light scattering functions for spherical particles of refractive index 2 have been computed in order to permit better interpolation of published functions. A.

535.43

1562. Recording radially symmetric scattering. K. L. YUDOWITCH. *J. Opt. Soc. Amer.*, **43**, 50–2 (*Jan.*, 1953).

Four fundamental methods are described for recording the intensity of radially symmetric scattered radiation as a function of scattering angle. The first and second arrangements utilize the conventional incident pencil of radiation. The first scheme scans a diameter of the scattering pattern in the customary fashion. The second scheme scans with axial translation of a circular ring aperture. The third scheme uses a divergent incident beam on a ring specimen and scans axially with a pinhole detector. The fourth scheme employs a beam from a ring source converging on to the specimen and records the intensity on the axis as a function of the angle of convergence, as the specimen is translated axially. The third arrangement is illustrated with an example which demonstrates its feasibility. A.

535.551 : 532.517.4

1563. An instrument for the study of double refraction of flow at low and intermediate velocity gradients. J. T. EDSALL, A. RICH AND M. GOLDSTEIN. *Rev. sci. Instrum.*, **23**, 695–701 (*Dec.*, 1952).

A compact concentric cylinder apparatus, for the study of double refraction of flow at low and intermediate velocity gradients, is described in detail. Since the outer cylinder is the rotor, relatively large gradients can be attained before turbulent flow sets in, even when the gap between the cylinders is as large as 0·2 cm. The light source is a zirconium concentrated arc lamp, used in conjunction with an interference filter. Sheets of selected Polaroid are used for polarizer and analyser; the field of view of the flowing liquid is large, so that at least three of the four arms of the cross of isocline are simultaneously visible. The polarizer remains in a fixed orientation. For measurements of extinction angle, the analyser remains fixed also, the angle being read by turning a reticule attached to a graduated scale. Birefringence is determined by a modified type of Senarmont compensator. A.

535.65

1564. Colorimetry of bronze paints. W. E. K. MIDDLETON AND A. G. MUNGALL. *J. Opt. Soc. Amer.*, **42**, 969–70 (*Dec.*, 1952).

In order to be able to compare bronze paints with ordinary standards such as Munsell papers, it is necessary to establish conditions of illumination and viewing which will render the metallic reflection inconspicuous. It has been found that completely diffuse illumination and normal viewing are highly satisfactory, and a small integrating sphere has been constructed which enables the comparison to be carried out with relative ease. The colours of 23 samples, measured in this way, correlate closely with those calculated from measurements on a recording spectrophotometer with the specular component included. A.

535.7 : 612.85

Physiological optics. *See Abstr.* 2108–15

535.8

1565. Radial symmetry in a schlieren image. R. B. EDMONDSON, E. L. GAYHART AND H. L. OLSEN. Letter in *J. Opt. Soc. Amer.*, **42**, 984–5 (*Dec.*, 1952).

A schlieren system uses a variable-size square aperture defining the light source, and a square mask to cover the image. A photograph shows the shock wave from an electric spark. R. W. FISH

535.8

1566. Lens testing bench. K. LEISTNER, B. MARCUS AND B. W. WHEELER, JR. *J. Opt. Soc. Amer.*, **43**, 44–8 (*Jan.*, 1953).

A versatile, precision lens testing bench is described. The construction is of such accuracy that all measured defects of imagery are due solely to the objective lens under test. The bench is of the nodal slide type and is provided with flat field bars. It accommodates lenses of all focal lengths up to 1220 mm and diameters from 0·5 in. to 7 in. It includes provisions for centring and revolving the lens under test, and the microscope is capable of being moved in three mutually perpendicular planes through calibrated micrometer screws. The microscope is capable of rotation about its object point through an angle of 100° to permit testing of telephoto lenses and lenses having extreme distortion. A procedure for adjusting the bench is discussed. Additions and alterations made are described. A.

535.822.1 : 531.719.1

Evaluation of small radii of curvature using the light-profile microscope. *See Abstr.* 1401

535.824.2–31

1567. An easily used ultra-violet microscope objective. M. H. F. WILKINS AND K. P. NORRIS. Letter in *Nature* [*London*] **170**, 883–4 (*Nov.* 22, 1952).

A solid objective is made from fused quartz with two spherical reflecting surfaces. It has a focal length of 1·7 mm, N.A. of 0·90, a central obstruction of 35% and can be used with an ordinary microscope. R. W. FISH

535.89

1568. A generator of short optical signals of square waveform. S. M. RAĬSKIĬ. Letter in *Zh. eksper. teor. Fiz.*, **22**, *No.* 6, 780–1 (1952) *In Russian.*

Describes a system of lenses, prisms, mirrors and slits to use with a projector lamp and a rotating mirror to produce square pulses of light of duration from about 2 μsec. By replacing the final slit by a grating a train of pulses may be produced. J. M. HOUGH

535.89 : 541.14

New high light intensity apparatus for photochemical reactions. *See Abstr.* 2020

HEAT 536

536.2.08

1569. Avoiding the guard ring in heat conductivity measurements in plate-shaped bodies. E. SCHMIDT. *Abhandl. Braunschw. Wiss. Gesell.*, **4**, 76–80 (1952) *In German.*

By theoretical investigation it is shown that exact measurements of heat conductivity are possible without a guard ring if the curvature of the isotherms is determined by additional measurements of differences of temperature on the surface of the plate in contact with the heater. For this purpose a set of four thermocouples in series is proposed for sufficient exactness. A.

536.21

1570. Rapid measurement of the thermal resistivity of soil. V. V. MASON AND M. KURTZ. *Pwr Apparatus Syst., No.* 1, 570–7 (*Aug.*, 1952).

Possible methods include the parallel plate system in the laboratory, observations on a buried heated body and transient methods. The latter are based on the fact that the ultimate temperature rise of a heated body and the rate of rise depend on the thermal constants of the immediate surroundings. A special needle containing a heater and a thermocouple is the heated body and it is inserted into a specially drilled hole. Time/temperature readings are plotted on semi-log paper and from the slope the thermal resistivity is calculated in ohm-cm. The full theory of this rapid method is given with a description of the equipment. E. H. DOCK

536.21

1571. The influence of lattice vibration spectrum on electronic thermal conductivity. F. H. J. CORNISH AND D. K. C. MACDONALD. Letter in *Phil. Mag.*, **43**, 991 (*Sept.*, 1952).

Present theory predicts a minimum in the thermal conductivity of a pure monovalent metal, whereas recent experiments on pure sodium showed no such minimum. The letter reports that the assumption of a constant lattice-wave velocity, which is made in the theory, is not the cause of this discrepancy.

P. T. LANDSBERG

536.21 : 536.24

1572. Stability and accuracy of numerical solutions of the heat flow equation. P. H. PRICE AND M. R. SLACK. *Brit. J. appl. Phys.*, **3**, 379–84 (*Dec.*, 1952).

The merits of different finite difference representations of the heat flow equation and a convection boundary condition equation are discussed in terms of the stability and accuracy of the solutions they yield. A new method of deriving a condition for stability is given. This is applied to examples of heat conduction involving variable thermal diffusivity and heat transfer by convection at the surface. Some finite difference forms of this boundary condition impose stability criteria which are stricter than, or additional to, that required in the case of a prescribed surface temperature. A new finite difference representation of the surface heat flux equation is discussed. The accuracy of the various finite difference schemes is investigated by comparing both their analytical and numerical solutions with analytical solutions of the differential equation of heat flow. A.

536.21 : 537.312.62

Heat conductivity of superconductive load below 1° K. *See Abstr.* 1647

536.21 : 538.222 : 548.736.5

1573. Physical properties of chromium alums at low temperatures. J. EISENSTEIN. *Rev. mod. Phys.*, **24**, 74–8 (*April*, 1952).

The following physical properties are reviewed: (i) crystal structure, (ii) structure changes, (iii) paramagnetic susceptibility, (iv) thermal conductivity, (v) paramagnetic resonance absorption, (vi) paramagnetic relaxation, (vii) specific heat, (viii) magnetic changes due to replacing Cr by Al ions (magnetic dilution), (ix) adiabatic demagnetization. Further experiments are suggested. E. P. WOHLFARTH

536.22 : 532.13

Viscosity and thermal conductivity of liquid argon. *See Abstr.* 1406

536.25 : 532.5

1574. The thermal instability of a fluid sphere heated within. S. CHANDRASEKHAR. *Phil. Mag.*, **43**, 1317–29 (*Dec.*, 1952).

The problem of the thermal instability of an incompressible fluid sphere heated within and in equilibrium under its own gravitation is considered. A general disturbance is analysed into modes in terms of spherical harmonics of various orders, l, and the criterion for the onset of convection for the first 15 modes is found both when the bounding surface is free and when it is rigid; and it is shown that in both cases the mode $l = 1$ is the first to be excited. A.

536.35

1575. Absorption and scattering of radiation by water sprays of large drops. P. H. THOMAS. *Brit. J. appl. Phys.*, **3**, 385–93 (*Dec.*, 1952).

An investigation of the efficiency of water sprays in the protection of buildings and fire-fighting personnel from heat radiation has resulted in a general theoretical study of the transmission of radiation through a layer of water spray of large drops. The treatment is based upon the work of Theissing (1950) and takes account of multiple refractive scattering in dense sprays and extends the method to absorbing sprays. The problem of the single drop is approached from the point of view of geometric optics, from which approximate expressions are derived for the absorption of a drop in terms of the absorption index for any given wavelength and for the angular distribution of radiation transmitted by a single drop. Since the absorption of thermal radiation depends markedly on the drop size it is found that the transmission of such radiation departs from the simple exponential extinction law when the drops and the quantities of water in the sprays are small. When the drops are less than about 0·005 cm in dia., back reflection by the spray may become significant. A.

536.413.2 : 536.424 : 541.64

1576. Second-order transition points in high polymers. K. L. FLOYD. *Brit. J. appl. Phys.*, **3**, 373–5 (*Dec.*, 1952).

An optical method of measuring the second-order transition points of high polymers by the change in

linear expansion is described. Various mixtures of Hycar OR15 and neoprene yield curves having two distinct and constant transition points. From these curves a relationship giving the composition of the mixture is derived. This may be of value in the analysis of elastomers. A.

536.42

1577. The effect of transformation pressure on latent heat of fusion of metals. K. HONDA AND M. SATÔ. *Proc. Japan Acad.*, **26**, 29–31 (*Jan.*, 1950).

Volume changes $\Delta V/V$ accompanying transformations may set up an internal pressure $p = 0{\cdot}355k\Delta V/V$, where k = bulk modulus of the transforming substance. Standard thermodynamic relations are used to calculate the effect of p on the latent heat of fusion L of Na, K and P. The changes in L agree fairly well with those arising from an externally applied pressure, equal to the calculated internal pressure, as observed by Bridgeman. A. D. LE CLAIRE

536.42

1578. The effect of transformation pressure on the difference of specific volumes in liquid and solid states of metals at melting points. K. HONDA AND M. SATÔ. *Proc. Japan Acad.*, **26**, 32–3 (*Jan.*, 1950).

The procedure of the preceding abstract is repeated for this case, with similarly satisfactory results.

A. D. LE CLAIRE

536.42 : 669

1579. An interpretation of hysteresis loops in A_3 and A_4 transformations in pure iron. K. HONDA AND M. SATÔ. *Proc. Japan Acad.*, **27**, 637–42 (*Dec.*, 1951).

These are attributed to internal stresses arising from volume changes ($\Delta V/V$) accompanying the transformations, which elevate the temperature of transformation on heating and lower it on cooling. An expression for the stresses is given, for the simple case of a cylindrical specimen in which any transformation starts at the surface and proceeds inwards, and with the Clausius–Clapeyron equation leads to a relation for the difference in the temperatures at which a transformation occurs on heating and on cooling. $\Delta T = \alpha KT(\Delta V/V)^2/\rho\lambda$ where $\alpha = 3/4$ if the maximum stress and 0·468 if the mean stress throughout the transformation, is used. K = bulk modulus, ρ = density and λ = latent heat of transformation. The observed values of ΔT lie between those calculated for the two values of α. A. D. LE CLAIRE

536.421.1 : 539.154.2

1580. On the melting points of transition metals. Z. G. SZABÓ AND B. LAKATOS. Note in *Naturwissenschaften*, **39**, *No.* 21, 486–7; Erratum, *No.* 24, 576 (1952).

When the melting temperatures of the 3 series of transition metals (Sc–Ni, Y–Pd and Hf–Pt) are plotted against 3 series of d^1–d^8, three similar curves are obtained, and elements belonging to the same vertical column lie on straight lines whose slopes increase from the Sc to the Mn group and then decrease to the Ni group. On plotting these slopes as the function of the unpaired d-electrons a bell-shaped curve is obtained. Analytical approximations of this function are given, and calculated melting temperatures of 23 transition metals are compared with the experimentally determined temperatures.

F. LACHMAN

536.423 : 532.65

1581. Evaporation of a liquid drop into a gas stream. E. G. RICHARDSON. *Proceedings of the General Discussion on Heat Transfer*, 1951 [*Instn Mech. Engrs and Amer. Soc. Mech. Engrs*]. *London, Institution of Mechanical Engineers* (1952) 66–8.

Data are given for evaporation from drops falling freely through air or suspended in a wind tunnel. The results are discussed theoretically.

L. G. CARPENTER

536.423.4 : 532.69

Condensation of vapour on solid surfaces. *See Abstr.* 1416–17

536.453

1582. Some details of the semi-industrial solar furnace at Montlouis. F. TROMBE. *C.R. Acad. Sci.* [*Paris*] **235**, 1211–13 (*Nov.* 17, 1952) *In French.*

The mountings of the furnace are illustrated and briefly described. See Abstr. 802 (1953). E. H. DOCK

536.46

1583. Determination of the velocity of burning. J. VAN STEENIS. Letter in *Nature* [*London*] **170**, 1068–9 (*Dec.* 20, 1952).

Examination of Schlieren photographs of flames may lead to erroneous values of the burning velocity, as the Schlieren image gives an incorrect representation of the object when there are steep density gradients (as in a flame). Phase-contrast photography eliminates this source of error, and experiments on coal-gas/air flames reveal differences of up to 10% in burning velocity between the two techniques.

A. SCHOFIELD

536.46 : 535.33.03

Apparent rotational temperatures of OH in emission and absorption. *See Abstr.* 1490

536.48

1584. A big expansion helium liquefier. A. J. CROFT. *J. sci. Instrum.*, **29**, 388–90 (*Dec.*, 1952).

A Simon single expansion helium liquefier is described which is now in routine use at Oxford. It makes 1·2 l. per expansion starting from 95 atm and 11°K, and one liquefaction takes less than an hour once the liquefier is cold. The consumption of liquid hydrogen is 5 l. per expansion. A.

536.48

1585. The vapor pressure of He^3–He^4 mixtures. R. A. NELSON AND W. BAND. Letter in *Phys. Rev.*, **88**, 1431 (*Dec.* 15, 1952).

Simple interpolation of the cluster theory of condensation [Abstr. 99 (1951)] as applied to the pure isotopes does not give agreement with experiments on mixtures. Some improvements of the method are discussed. H. LONDON

536.48 : 536.65

1586. On the latent heat and vapour density of helium. R. BERMAN AND J. POULTER. *Phil. Mag.*, **43**, 1047–54 (*Oct.*, 1952).

The volume of vapour evolved from liquid He by known amounts of heat has been measured at temperatures between 2·9 and 4·5°K. The derivation of

latent heat values from these results is discussed, and it is shown that the existing experimentally determined values of the saturated vapour density are not sufficiently reliable for this purpose. The probable true values of the vapour density are considered. A.

536.48

1587. Film flow and the behaviour of He cryostats below the λ-point. E. Ambler and N. Kurti. *Phil. Mag.*, **43**, 1307–16 (*Dec.*, 1952).

A description is given of experiments which confirm in detail the mechanism proposed by Rollin and Simon concerning the behaviour of the helium film in pumping tubes of low temperature cryostats. In particular the temperature distribution along these tubes which, as a result of the film, is of an unusual nature, was determined. Experiments were carried out both on tubes having uniform cross-sections and on tubes containing a constriction, and it is shown how the above mechanism can be used to measure film transfer rates in each case. The results are finally discussed from the point of view of the design of helium cryostats. A.

536.5.081

1588. Present status of temperature scales. H. F. Stimson. *Science*, **116**, 339–41 (*Oct.* 3, 1952).

The International Temperature Scale has been defined in terms which make it represent the thermodynamic scale in a practical manner. Fixed temperatures and methods of interpolating in the different ranges are briefly discussed. The Kelvin will probably be defined in terms of a single parameter, namely the triple point of water. It has been suggested that the name Celsius replace the description Centigrade. E. H. DOCK

536.5.081.3/.4 : 538.222

1589. Adiabatic demagnetization and the temperature scale below 1°K. D. de Klerk. *Science*, **116**, 335–9 (*Oct.* 3, 1952).

A review. A brief historical and theoretical discussion of the demagnetization method is followed by a consideration of measurements of the magnetic temperature C/χ. This deviates considerably from the absolute temperature at the lowest temperatures, and direct methods of measurement of T in this range are described. The influences of hysteresis effects are discussed. Results given refer to the properties of KCr alum, other salts being only briefly referred to. E. P. WOHLFARTH

536.532 : 536.48

1590. Recording and indicating instruments for temperature measurements down to 10°K using copper-Constantan thermocouples. E. V. Larson and R. Mayer. *Rev. sci. Instrum.*, **23**, 692–4 (*Dec.*, 1952).

Briefly discusses the modifications and additions to a standard instrument involved in the solution of the problems encountered in the indication and recording of temperatures as low as 10°K with CC thermocouples as the primary elements. A.

536.581

1591. Application of the method of fusion of roots to the study of the stability of the automatic regulation of a heat exchanger. P.-L. Dubois-Violette. *C.R. Acad. Sci.* [*Paris*] **235**, 1111–13 (*Nov.* 10, 1952) *In French.*

Results obtained previously [Abstr. 971 (1952)] are applied to a consideration of the control of the outflow temperature of a liquid heated by condensation of water vapour. It is shown that the efficiency of the regulation is improved by a derivative control system. F. E. HOARE

536.631

1592. On the anomaly in the heat capacity of manganous oxide. R. K. Wangsness. *Science*, **116**, 537 (*Nov.* 14, 1952).

Measurements by Todd and Bonnickson (1951) show that on raising the temperature from 100° to 122°K the total heat absorbed is 246 cal mol^{-1}. A contribution 154 cal mol^{-1} is ascribed to the lattice vibrations, and a contribution 44 cal mol^{-1} to the disappearance of spontaneous magnetization at the antiferromagnetic Curie temperature (122°K). The residue is interpreted as due to a change of ordering from the second to the third kind [Abstr. 6313 (1951)] in this temperature range. E. P. WOHLFARTH

536.631

1593. Anomalous specific heat of chromium oxide (Cr_2O_3) at the antiferromagnetic Curie temperature. J. Volger. Letter in *Nature* [*London*] **170**, 1027 (*Dec.* 13, 1952).

The specific heat/temperature curve has a λ-point at about 35°C, close to the antiferromagnetic Curie temperature (45°C) which was determined by susceptibility measurements. E. P. WOHLFARTH

536.631

1594. On θ values in metals. F. M. Kelly and D. K. C. Macdonald. *Canad. J. Phys.*, **31**, 147–64 (*Jan.*, 1953).

Following a discussion of specific heat theories, it is suggested that, despite its limitations, the Debye theory is the most useful representation for general analysis. Four methods of calculating θ_D, the Debye characteristic temperature, are presented; specific heat data of Li, Na and K are then analysed and also compared with similar calculations of θ_R from resistance measurements made over a wide temperature range. It is shown that more realistic values of θ are obtained when θ is recognized as a temperature-dependent parameter in the mathematical derivation of the relevant equations. It appears that a considerable amount of useful information may be obtained from data analysis in this way. A.

THERMODYNAMICS 536.7/.8

536.7

1595. On a theorem of irreversible thermodynamics. II. R. F. Greene and H. B. Callen. *Phys. Rev.*, **88**, 1387–91 (*Dec.* 15, 1952).

For Pt I, see Abstr. 5750 (1952). The fluctuation-dissipation theorem, which relates the equilibrium

fluctuations to the admittance of a thermodynamic linear dissipative system, is generalized for more than a single extensive parameter. The real part of the admittance is shown to be symmetric, supplying thereby an extension of the reciprocity theorem of Onsager. The analysis is macroscopic and thermodynamic in nature, and is carried out for adiabatic constraints as well as for microcanonical constraints. A.

536.7 : 530.162

Statistical mechanics of irreversibility. *See Abstr.* 1399

536.7 : 533.15 : 537.226 : 541.18.043

1596. Energy dissipation and entropy production in irreversible processes of dilute systems. N. Saitô and M. Sugita. *J. Phys. Soc. Japan*, **7**, 554–9 (*Nov.–Dec.*, 1952).

A thermodynamical treatment of the diffusion of ideal gases, sedimentation of dilute colloidal solution, dielectric anomalies of polar solution and intrinsic viscosity of macromolecules of non-spherical shape. In all these phenomena an important role is played by differential equations of diffusion type which determine the distribution functions of molecules and the currents of the probability density. It is shown that the energy dissipation and the entropy increase multiplied by absolute temperature are given by the work done by the external force and by the diffusion force, respectively, against the current of the probability density; in particular the irreversible production of entropy multiplied by absolute temperature is given by the heat produced by the friction of the particles with velocity equal to the current of the probability density. Finally, the theories of W. Kuhn, H. Kuhn and one of the authors for the non-Newtonian viscosity of macromolecules are discussed and the equivalence of the final results of the two theories is demonstrated. A.

536.7 : 536.633

1597. The thermodynamic properties of sodium vapor. A. Benton and T. H. Inatomi. *J. chem. Phys.*, **20**, 1946–8 (*Dec.*, 1952).

The free energy, enthalpy, entropy, and specific heat for both monatomic and diatomic sodium vapour have been calculated from spectroscopic data by the well-known methods of statistical mechanics. Also, the equilibrium constant K_p for the gaseous reaction $Na + Na = Na_2$, as well as the entropies and enthalpies for the equilibrium mixture of these two species, were obtained. These calculations were made for the vapours as ideal gases at a pressure of 1 atmosphere, and for the temperature range 100°K to 2600°K. The results are presented in tables. A.

536.7 : 541.135

Thermodynamics of irreversible electrochemical processes. *See Abstr.* 2012

536.71

1598. Constants in the equation of state of a gas. L. F. Epstein. Letter in *J. chem. Phys.*, **20**, 1981–2 (*Dec.*, 1952).

Series reversal methods are used to derive a formula expressing the volume of a gas explicitly in terms of the pressure and of the virial coefficients. E. H. Sondheimer

536.73 : 536.75

1599. Relation between the principle of retarded potentials and the second principle of thermodynamics. O. Costa de Beauregard. *C.R. Acad. Sci.* [*Paris*] **235**, 1193–4 (*Nov.* 17, 1952) *In French.*

Considers the variation in entropy of a system consisting of a macroscopic emitter + free photons during the emission or absorption of photons. F. E. HOARE

536.75

1600. Organization and entropy. J. Rothstein. Letter in *J. appl. Phys.*, **23**, 1281–2 (*Nov.*, 1952).

Development of the measurement-communication analogy of entropy in which it is shown that precise formulation of the concept of organization leads to its characterization as a kind of negative entropy. Organization is of the nature of information encoded in structure and the idea leads to a generalization of the entropy-information concept. Measurement and interaction in general appear in a new light against the background of these concepts and it is shown that a theory may be considered as organization of observation. F. E. HOARE

ELECTRICITY 537

537.081.5 : 621.3.081

1601. Dimensional analysis, units and rationalization. R. Vermeulen. *Philips Res. Rep.*, **7**, 432–41 (*Dec.*, 1952).

Undiscriminating manipulation of dimensional formulae can lead to contradictions, e.g. that 1 sec = 3×10^{10} cm or that 1 oersted = 1000 A/m. These are eliminated by defining the multiplication of physical quantities, and by preventing the mixing up of multiplications whose physical interpretations are essentially different. The same measures solve difficulties connected with the introduction of the rationalized Giorgi-system. A.

THEORY . ELECTRONS 537.1

537.12

1602. Microwave spin resonance absorption by conduction electrons in metallic sodium. T. W. Griswold, A. F. Kip and C. Kittel. Letter in *Phys. Rev.*, **88**, 951 (*Nov.* 15, 1952).*

Fine particles (dia. 10^{-4}–10^{-5} cm) of Na suspended in paraffin wax placed in a microwave cavity showed resonance absorption at 9240 Mc/s. The signal decreased about five times on cooling to 77°K, possibly due to the lower resistance of Na. The width of the resonance was 78 oersted. The spectroscopic splitting factor is between 1·998 and 2·004. L. Pincherle

ELECTROSTATICS . DIELECTRICS 537.2

537.21

1603. Numerical calculation of the potential and flux due to a uniformly charged disk. M. LAUDET. *J. Phys. Radium*, **13**, 549–53 (*Nov.*, 1952) *In French.*

Different methods are compared and their limitations indicated. The potential is expressed in 3 forms, as a Taylor expansion series, a Legendre polynomial series and an integral containing Bessel functions. Finally the relaxation method is used to calculate the flux as well as the potential. A. E. KAY

537.226

1604. The dispersion formulae and polarization fields. K. S. KRISHNAN AND S. K. ROY. Letter in *Phil. Mag.*, **43**, 1000–2 (*Sept.*, 1952).

The generalized Lorentz and the Drude dispersion formulae are compared. D. H. WHIFFEN

537.226

1605. Clausius–Mosotti equation for anisotropic crystals. H. J. NEUGEBAUER. Letter in *Phys. Rev.*, **88**, 1210 (*Dec.* 1, 1952).

537.226.2

1606. Use of extrapolation formulae in dielectric polarization studies. N. PILPEL. Letter in *Research*, **5**, 444 (*Sept.*, 1952).

The results obtained by using four different extrapolation formulae are compared with those obtained graphically for nine binary liquid mixtures. The agreement is, in general, good. No views are expressed as to which is the most reliable extrapolation formula, but, in view of the greater simplicity of the calculations the method of Smith and Cleverdon, possibly taken in conjunction with that of Palit and Banerjee, is preferred. A. J. MEE

537.226.2

1607. Dielectric constant of water films. L. S. PALMER, A. CUNLIFFE AND J. M. HOUGH. Letter in *Nature* [*London*] **170**, 796 (*Nov.* 8, 1952).

Abnormally low dielectric constants seem to be associated with water in the form of thin films on surfaces. Preliminary experiments on mica sheets with water films between them suggest that the low value disappears at low frequencies and this suggests that some of the water present in these films is more like ice than water. It is suggested that water in this form might be called liquid ice. J. M. HOUGH

537.226.2

1608. The frequency dependence of the dielectric properties of dipolar substances. J. J. O'DWYER AND R. A. SACK. *Austral. J. Sci. Res. A*, **5**, 647–60 (*Dec.*, 1952).

A critical review of theories is given and inconsistencies are pointed out in previous attempts to account for dipolar interaction. A new theory is presented based on Debye's theory of molecular relaxation and using Onsager's method for treating electrostatic interaction. Fluctuations are considered explicitly both in the orientation of an individual dipole and in the local field acting on it; a distinction is also made between the experimentally measurable time constants and the relaxation times governing molecular processes. The results are presented in the form of a series development in powers of the dipolar concentration. In first approximation the theory leads to a Debye frequency dependence of the dielectric constant; in second approximation a Debye dependence can be made consistent with the molecular mechanism only for a more restricted (two-position) model. A.

537.226.2

1609. Temperature dependence of the dielectric properties of long-chain aliphatic alcohols in the solid state. J. S. DRYDEN. *Austral. J. sci. Res. A*, **5**, 661–70 (*Dec.*, 1952).

The dielectric properties of three primary and three secondary long-chain aliphatic alcohols have been investigated within the temperature range of −20 to 70°C. The experimental results are discussed in relation to the theory of Sack [Abstr. 4333 (1952)] on dielectric absorption in linear polar chains and to the conclusions reached in earlier papers on the dielectric properties of these compounds. The apparent activation energies in the primary alcohols are approximately three times those in the secondary alcohols. This indicates either different mechanisms of absorption in the two types of alcohols or, if the mechanisms are the same, significant differences in the energy barriers involved. A.

537.226.2

1610. Dielectric constants of solutions of charged particles. G. K. FRAENKEL. *J. chem. Phys.*, **20**, 1931–3 (*Dec.*, 1952).

Calculations are carried out to determine the relation between the dielectric constant of solutions of large charged particles and the charge distribution on the particles. It is shown that if the hydrodynamic forces cause the particles to rotate about a point fixed in each particle, the dielectric constant is determined by the dipole moment about this point. A.

537.226.2

1611. Ferroelectricity in oxides of fluorite structure. W. R. COOK, JR AND H. JAFFE. Letter in *Phys. Rev.*, **88**, 1426 (*Dec.* 15, 1952).

The ferroelectric properties of cadmium niobate $Cd_2Nb_2O_7$ are confirmed, the Curie point being −103°C. The crystal structure is cubic and of fluorite type. Similar experiments on $Pb_2Nb_2O_7$ suggest a similar structure and indicate possible ferroelectric behaviour at low temperatures.

G. F. J. GARLICK

537.226.2

1612. Dielectric dispersion in the microwave region of six tetrasubstituted methanes in the solid state. J. G. POWLES, D. E. WILLIAMS AND C. P. SMYTH. *J. chem. Phys.*, **21**, 136–41 (*Jan.*, 1953).

A method is described for the measurement of dielectric constant and loss at microwave frequencies and low temperatures. The dielectric constant and loss at 3·22 cm wavelength ($9{\cdot}32\times10^9$ c/s) have been measured over a range of temperature in the solid state and in the liquid near the melting point for *t*-butyl chloride, *t*-butyl bromide, 2,2-dichloropropane, methyl chloroform, 2-chloro–2-nitropropane, and 2, 2-dinitropropane. 1, 1-Dichloro–1-nitropropane also has been measured as a supercooled liquid. The

six tetrasubstituted methanes, previously found to show molecular orientational freedom in the solid state for some distance below the melting point, give evidence of very short dielectric relaxation times in this region. The relaxation times increase from a very low value for *t*-butyl chloride to values such that large dielectric loss is observed near 3 cm for 2-chloro–2-nitropropane and 2,2-dinitropropane. The relaxation times in the solid rotator phases and in the liquid are compared, and the results are discussed in terms of intermolecular forces which give rise to potential energy barriers restricting rotation. A.

537.226.2

1613. Hysteresis loops of ceramic barium titanate at higher frequencies. I. K. KAMBE, I. NAKADA AND H. TAKAHASI. *J. Phys. Soc. Japan*, **8**, 9–14 (*Jan.–Feb.*, 1953).

Field-polarization hysteresis loops of ceramic barium titanate at high frequencies have been observed by a cathode-ray tube. To prevent the temperature rise due to hysteresis loss, pulsed voltage was used. The frequency was increased up to the order of 1 Mc/s, but the loop did not show any drastic change, except the gradual decrease of the maximum polarization and of the average slope of the loop. The temperature dependence was also examined between the room temperature and about 150°C. A.

537.226.2

1614. Hysteresis loops of ceramic barium titanate at higher frequencies. II. K. KAMBE. *J. Phys. Soc. Japan*, **8**, 15–20 (*Jan.–Feb.*, 1953).

The effect of the use of pulsed voltage on the hysteresis loop was examined using rectangular pulses at a frequency of the order of 10 kc/s. Initial transient phenomena in obtaining a dynamical hysteresis loop was studied using pulses with very small number of swings. The characteristic shape of the loop for pulsed voltage was found to correspond to the initial stage of the loop for continuous voltage. The remanence and its decay could be directly observed oscillographically. A.

537.226.2 : 534.23

Dielectric and ultrasonic relaxation in glycerol. *See Abstr.* 1456

537.226.2 : 537.311.35

1615. Dielectric absorption and d.c. conductivity in *n*-primary alcohols. B. V. HAMON AND R. J. MEAKINS. *Austral. J. sci. Res. A*, **5**, 671–82 (*Dec.*, 1952).

A previous publication [Abstr. 275 (1952)] described some electrical properties of crystalline *n*-primary alcohols of 16 to 26 carbon atoms. The present paper deals with an extension of the work to the lower homologues down to *n*-octyl alcohol, and includes the results of measurements on both the liquid and crystalline materials. To enable their more extensive investigation, the frequency range of measurement has been extended down to 10^{-4} c/s by the use of d.c. methods. The alcohols of the present series resemble the higher homologues in giving two regions of dielectric absorption which overlap to an increasing extent with decreasing molecular weight. The absorption region at lower frequencies merges with the loss due to d.c. conductivity, the latter being much larger than for other long-chain compounds so far investigated. A feature of the results is the variation in the electrical properties of different samples of the same alcohol. This may be due to variations in the relative proportions of α- and β-crystalline modifications present in different samples. The results suggest that the absorption and the d.c. conductivity both depend on the presence in the crystals of hydrogen-bond chains. The high frequency absorption appears to be related to that in secondary alcohols and is probably associated with reversal of the hydrogen-bond chains by cooperative rotation of the hydroxyl group about the C–O bonds. The latter mechanism, together with proton transition, could lead to migration of the protons, and this may account for the d.c. conductivity. The absorption at low frequencies is attributed to a Maxwell–Wagner type of mechanism resulting from the situation of the conducting hydrogen-bond chains in a non-conducting matrix. A.

537.226.2 : 548.5

1616. Dielectric observations of nucleation. V. DANIEL AND C. TURNER. Letter in *Nature* [*London*] **170**, 1122 (*Dec.* 27, 1952).

A mixture of five equivalent ketones $C_mH_{2m+1}.CO.C_{17-m}H_{35-2m}$ which has a stable multiphase form and a metastable single-phase form is used for measuring dielectric properties during precipitation. C. TURNER

537.226.2 : 548.736.4

1617. A static model of $BaTiO_3$ at room temperature. R. HAGEDORN. *Z. Phys.*, **133**, *No.* 3, 394–421 (1952) *In German.*

Assuming a fixed axial ratio for the tetragonal crystal lattice and independent *z*-axis displacements of the Ti and O ions from body-centred or face-centred positions, and computing the *z*-component of electric field as a function of *z* along 3 chosen lines parallel to the *z*-axis, a system of 4 equations is obtained which includes the effects of the polarizabilities of the ions and the presence of an externally applied static field. Numerical solution leads for a simple ionic model to a spontaneous polarization much greater and a permittivity significantly less than observed. A modified model is examined which leads to reduced effective ionic charges, so indicating a component of homopolar binding in the lattice. This is supported by the low observed optical refractive index. F. F. ROBERTS

537.226.2 : 621.3.011.5 : 621.315.61

1618. Study of dielectrics; dielectric constant, dielectric loss and breakdown. I. M. BOUIX. *Ann. Télécomm.*, **7**, 466–79 (*Nov.*, 1952) *In French.*

Reviews modern theories of dielectrics. Deals with the effects of stationary and varying fields on non-polar, polar and dipolar substances, the formulae of Onsager, Clausius–Mosotti, Kirkwood and Fröhlich and the Debye model. I. D. L. BALL (R)

537.226.2 : 621.3.011.5 : 621.315.61

1619. Study of dielectrics; dielectric constant, dielectric loss and breakdown. II. M. BOUIX. *Ann. Télécomm.*, **7**, 497–512 (*Dec.*, 1952) *In French.*

The formulae obtained in I are applied to experimental results The author ends with a description

of Fröhlich's theory of intrinsic electric breakdown in solids and the work carried out on ionic crystals and long-chain polymers in this field. I. D. L. BALL (R)

537.226.2 : 621.3.015.5 : 621.317.333.6

1620. An experimental investigation of factors influencing the electric strength of potassium chloride crystals. J. H. CALDERWOOD, R. COOPER AND A. A. WALLACE. *Instn Elect. Engrs Paper* 1457, 6 *pp.* (1953).

Experiments with single crystals are described, showing that the electric strength of KCl is not significantly affected by the choice of electrode material. It is, however, considerably increased by treatments that introduce the structural defects, associated with residual strains, caused by plastic deformation. This does not seem to have been appreciated in the past. Structural defects of this sort can be created very easily, and great care is therefore required to obtain measurements of electric strength for strain-free crystals. It is speculated that this has not yet been done for crystals of any of the alkali halides. The electric strengths of strain-free crystals are the values suitable for comparison with existing theoretical predictions, and they may be as much as 50% less than those usually quoted for the alkali halides at room temperature. A.

537.226.2 : 621.317.335.3

1621. A rapid procedure for working out the results of measurements obtained by the hyperbolic tangent method. G. A. OSTROUMOV. *Zh. tekh. Fiz.*, **21**, *No.* 8, 948–61 (1951) *In Russian.*

When determining the complex dielectric constant of a substance at u.h.f. using Lecher's system, half-width of the resonance curve is plotted as a function of its position with respect to the maximum. The various points on the graph, obtained by investigating layers of the substance of various thicknesses (about half wavelength), are shown to lie on a circle. A rapid method of determining the impedance of a system from the size and position of this circle is presented. A. GELBTUCH

537.226.2 : 621.317.335.3

1622. A quickly made dielectric constant cell. R. E. WOOD. *Science*, **116**, 358–9 (*Oct.* 3, 1952).

A cell for measurements on fluids is constructed from an all-metal type 6H6 radio valve (double diode). Fluid inlet and outlet pipes are soldered into the "top" of the metal shell of the valve which also serves as electrical shield or earthed electrode. The capacitance is measured between various combinations of the diode electrodes and the shell. About 10 ml of fluid is sufficient to fill the cell. A thermostat jacket is easily formed around the cell. F. F. ROBERTS

537.226.3 : 537.311.33

1623. The new method of studying lattice defects in solids by Debye absorption: case of semiconductors. M. FREYMANN AND R. FREYMANN. Letter in *J. chem. Phys.*, **20**, 1970–1 (*Dec.*, 1952).

The Debye absorption of solids for radiowaves of kilometre to centimetre wavelengths provides a method of investigating lattice defects, which show a dipole behaviour. In halides and oxides these dipoles are found with characteristics from which the activation energy of the corresponding defects might be calculated. G. F. J. GARLICK

537.226.31

1624. On the behaviour of the dielectric loss factor of natural wood in the high frequency range. K. KRÖNER AND L. PUNGS. *Abhandl. Braunsch. Wiss. Gesell.*, **4**, 127–45 (1952) *In German.*

Research on the dielectric anisotropy of wood in the frequency range of $3\times10^2 \ldots 10^9$ c/s has been extended by the measurement of the dielectric losses. The anisotropy originates in the macroscopical structure; the maximum of the loss factor tan δ at rather high frequencies is explained by the dipole-character of cellulose. The effect of water contained in the wood on the dielectric properties at higher frequencies is explained by the influence which the water molecules exercise on the vibration of the dipole groups of the cellulose. At low frequencies the influence of moisture comes from the inhomogenity, corresponding to Wagner's theory of dielectric losses. A.

537.228.1:621.317.32:621.395.623.45:621.396.611.21

1625. On voltage measurements on Rochelle salt under compressive load. B. PÜSCHEL. *Arch. tech. Messen, Issue No.* 200 (*Ref.* V 943–1) 197–8 (*Sept.*, 1952) *In German.*

Measurements which are easily made on quartz are difficult with Rochelle salt because of the latter's poor insulation. A weight of 50 g is dropped from various heights up to 100 cm in a cylindrical tube on to a crystal whose front face is protected by a rubber sheet 1 mm thick. A variable capacitance is connected across the crystal and the voltage developed across the combination is recorded on an oscillograph. A more accurate method is described where the crystal is connected between anode and cathode of a biased thyratron whose static characteristics are known. The results for different heights and capacitances are tabulated. A scheme for extracting charge from the crystal is shown in which the crystal, a gas diode and a capacitance are connected in series. S. C. DUNN

537.228.2 : 538.652

1626. On the theory of electro-striction vibration—substitution of magnetostriction theory. Y. KIKUCHI. *Rep. Res. Inst. Elect. Commun. Tôhoku Univ.*, **3**, *No.* 1, 7–12 (1951).

The phenomena of electrostriction, such as the elongation of barium titanate ceramic by the impression of electric field, are similar to those of magnetostriction rather than to those of piezo-electricity, and therefore the author introduces a new definition for electrostrictivity in the form similar to magnetostrictivity which has already been proposed by him and conveniently used to develop many theories on magnetostriction vibration. Then the correspondence is discussed between the two phenomena and a method introduced for the substitution of magnetostriction theory for the theory of electrostriction vibration. By this consideration, almost all theories for magnetostriction vibration, especially the universal chart of effective attenuation,

can be utilized directly for the case of electrostriction vibration. The required characteristics of electrostrictive material are also discussed for the case of utilization in liquid such as water or oil. A.

537.228.4

1627. The Kerr effect in Onsager liquids. G. KLAGES. *Z. Naturforsch.*, **7a**, 669–76 (*Oct.*, 1952) *In German.*

As the Kerr constant of a liquid depends directly on the electric forces acting on each molecule, its calculated value depends on the choice of a liquid model. Clausius and Mosotti derive their formulae from the Lorentz-field conditions, but for liquids, the values found for the Kerr constants are too big. Debye considers the fact that in the immediate neighbourhood of each molecule the arrangement of the molecules does not correspond to the statistical formation. This leads to the introduction of a reduction factor, which involves empirical parameters. The Onsager model supposes the molecule to be spherical with a central permanent dipole moment and a continuous medium around it. The Kerr constant is calculated, which involves a reduction factor but no empirical parameter. For non-polar liquids the relation does not hold, as the reduction factor becomes unity, so that the discrepancies remain. For polar liquids with rigid molecules there is good agreement with experiment. If there is internal mobility the agreement is not so good, as the shape of the molecule may be different in the gaseous and liquid phases. For molecules with large anisotropy it is sometimes necessary to take a liquid structure into account. The dependence of the Kerr constant upon temperature is considered: at higher temperatures there is better agreement with experiment, as statistical conditions are better satisfied. For mixtures similar formulae are derived: there is little difference between the Lorentz and the Onsager field, except for strongly polar substances and when the refractive indices of the components differ very much. The Onsager theory predicts little variation of the Kerr constant with concentration, whilst the Clausius–Mosotti theory predicts a steady decrease. A. J. TAYLOR

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3 : 621.317.713

1628. A direct current microampere integrator. R. N. SCHWEIGER. *Rev. sci. Instrum.*, **23**, 735–8 (*Dec.*, 1952).

A current integrator with a current range of 0–10/1000 microamperes consisting of a feedback stabilized current amplifier whose output is fed to the current coil of a modified Thompson watthour meter is described. Inasmuch as the no-load speed of this meter is directly proportional to the current supplied, the desired integrated result is obtained by the use of a revolution counter operating at nearly zero torque. The net accuracy achieved is about one per cent of full scale. A.

537.311.1

1629. The two-band effect in conduction. R. G. CHAMBERS. *Proc. Phys. Soc.* [*London*] *A*, **65**, 903–10 (*Nov.*, 1952).

For an isotropic two-band conductor in a transverse magnetic field, the various galvanomagnetic, thermomagnetic and thermoelectric coefficients are derived by elementary arguments in terms of those of the individual bands. The expressions are applicable to quasi-free electrons of any degree of degeneracy: for fully degenerate electrons they reduce to those already given by Sondheimer and Wilson. When the square of the thermoelectric power is comparable with the Lorenz number, as may happen in semiconductors, the expressions for the adiabatic thermomagnetic and thermoelectric effects become extremely complicated, though those for the isothermal effects remain reasonably simple. A.

537.311.1

1630. Polaron theory. S. I. PEKAR. *Zh. tekh. Fiz.*, **22**, *No.* 6, 1076–85 (1952) *In Russian.*

In continuation of this discussion [*Zh. tekh. Fiz.*, **21**, 1544 (1951)] it is pointed out that the polaron theory differs essentially from the usual zonal theory, firstly by the strong correlation between movement of ions and conductivity electron (adiabatic correlation), furthermore by the fact that in any given configuration of ions the wave function of the electron is of the local type (i.e. exponentially damped) which follows from a treatment considering the translational symmetry of the problem correctly. Also, in the polaron theory the effective mass of the current carriers is determined by the eigenfrequency of the limiting ion vibrations; with the appearance of every current carrier the number of degrees of oscillatory freedoms of the ions is reduced by 3, etc. There is nothing like it in the usual zonal theory. Further points: May the polaron move through the crystal when the electron is described by a damped wave function? Problem of the polaron radii, etc.

B. F. KRAUS

537.311.32

1631. Electrical conductivity of caesium chloride near the thermal transition. W. W. HARPUR AND A. R. UBBELOHDE. Letter in *Nature* [*London*] **170**, 975 (*Dec.* 6, 1952).

A sharp decrease in conductivity σ near the transition pt. 469°C is observed experimentally. It is assumed that the change of crystal structure is responsible for the change in σ and not necessarily an increase in the defect concentration on approaching the transition temperature. C. A. HOGARTH

537.311.32

1632. The influence of absorbed oxygen on the electrical conductivity of zinc oxide. H. FRITZSCHE. *Z. Phys.*, **133**, *No.* 3, 422–37 (1952) *In German.*

Measurements of the electrical conductivity of sputtered ZnO films suggest that absorbed oxygen molecules act as trapping centres and at high temperatures diffuse out of the ZnO lattice. The chemical processes taking place during oxidation or heating of the layers (of order 0·1 μ thick) are discussed.

C. A. HOGARTH

537.311.32 : 541.135.4

1633. On pre-exponential factors in formulae for ionic conductivity in solids. Y. HAVEN AND J. H. VAN SANTEN. *Philips Res. Rep.*, **7**, 474–7 (*Dec.*, 1952).

It is pointed out that, if in formulae for equilibrium constants and rate constants the energy is linearly dependent on temperature, $E = E_0 - \alpha T$, the pre-exponential factor is not increased by a factor $\exp(\alpha/k)$. A.

537.311.33

1634. Current-noise in semi-conductors: a re-examination of Bernamont's data. D. A. BELL. *Phil. Mag.*, **43**, 1107–1111 (*Oct.*, 1952).

In 1937 Bernamont published the results of his experiments showing that the current-noise in certain thin metal films varied approximately as the inverse of the frequency over the range 96 to 162 000 c/s. The text of his paper shows, however, that he omitted to allow for the presence of Johnson noise when the steady current was reduced to zero. After correcting for this, and making another adjustment necessary to make the results physically possible, the noise from his resistor "B" shows a close inverse-frequency law for all current densities, whereas Bernamont found an inverse power of the frequency varying between 0·883 and 0·983 for different values of current. A.

537.311.33

1635. Modulation of the conductance of a semi-conductor by an electric field. P. AIGRAIN, J. LAGRENAUDIE AND G. LIANDRAT. Letter in *J. Phys. Radium*, **13**, 587–8 (*Nov.*, 1952) *In French.*

An a.c. method for the investigation of conductivity modulation of a thin film of semiconducting material by an electric field is outlined. Some results for thin films of tellurium deposited on mica are reported. C. A. HOGARTH

537.311.33

1636. Experimental verification of the relationship between diffusion constant and mobility of electrons and holes. *Phys. Rev.*, **88**, 1368–9 (*Dec.* 15, 1952).

The relationship between diffusion constant and mobility, called the Einstein relationship, has been experimentally verified for electrons and holes in germanium. This has been accomplished by measuring the rate of increase in half-concentration width of a pulse of minority carriers moving in an electric field. A.

537.311.33

1637. Surface properties of germanium. W. H. BRATTAIN AND J. BARDEEN. *Bell Syst. tech. J.*, **32**, 1–42 (*Jan.*, 1953).

The contact potential (c.p.) and the change of contact potential with illumination $(\Delta c.p.)_L$ of several Ge surfaces have been measured. The reference electrode used was Pt. It was found that the c.p. could be cycled between two extremes about 0·5 volts apart by changing the gaseous ambient. O_3 or peroxide vapours gave the c.p. extreme corresponding to the largest dipole at the Ge surface. Vapours with OH radicals produced the other extreme. There is a one-to-one correlation between c.p. and $(\Delta c.p.)_L$. For 12-ohm cm *n*-type Ge $(\Delta c.p.)_L$ was large and positive when the surface dipole was largest, decreased to zero and became slightly negative as the surface dipole decreased to its smallest value. The variation for 12-ohm cm *p*-type Ge was just opposite as regards both sign and dependence on surface dipole. The surface recombination velocity was found to be independent of c.p. For a chemically prepared surface it was 50–70 cm/sec and 180–200 cm/sec for *n*- and *p*-type surfaces respectively. A theory is given that explains the results in terms of surface traps, N_a per cm² donor-type traps near the conduction band and N_b per cm² acceptor-type traps near the filled band. A quantitative fit with experiment is obtained with only one free parameter. The results are direct evidence for the existence of a space charge layer at the free surface of a semiconductor. A.

537.311.33

1638. On the semiconducting properties of intermetallic compounds (CdSb). E. JUSTI AND G. LAUTZ. *Abhandl. Braunschw. Wiss. Gesell.*, **4**, 107–16 (1952) *In German.*

The stoichiometric intermetallic compounds of binary systems (e.g. Au–Cu) show minima of electrical resistivity connected with their high crystallographic order. Such compounds reach approximately the resistivity of the pure components. In contradiction to these older statements the authors report new experiments with other binary alloys (e.g. Cd–Sb) which show a sharp increase of resistivity by 4 to 5 orders of magnitude when stoichiometric composition is being reached. The new measurements of the temperature dependence of resistivity between 10° to 700°K prove, in accordance with the Hall effect, the magnetic increase of resistance, the thermoelectric force and the rectifying properties, that these intermetallic compounds behave as true intrinsic and extrinsic semiconductors. Pure stoichiometric CdSb can reach $\rho_{293°} = 2 \cdot 4$ ohm-cm. A theoretical explanation of these experimental statements is given in terms of the electron theory of metals. The authors point out how the CdSb with its known rhombic crystal structure becomes semiconductive by completion of the seventh Brillouin zone. In conclusion the authors discuss the possibilities of technical use of such intermetallic semiconducting compounds instead of Ge and Si in diodes or transistors. A.

537.311.33

1639. Electrical conductivity of alkaline borosilicate glasses. B. I. MARKIN. *Zh. tekh. Fiz.*, **22**, *No.* 6, 932–40 (1952) *In Russian.*

The electrical conductivity of Na, K and Na–K borosilicate glasses was measured. In all cases it is represented by the equation $\log K = -A/T + B$, where T is absolute temperature, and A and B are constants. The conductivity of 3-component Na and K glasses increases by a factor of 10^5 if the alkali concentration increases several times. For alkali concentrations $< 2 \cdot 1 \times 10^{-2}$ g. atom/ml the conductivity of K-glasses < Na-glasses. At higher concentrations the conductivities are practically equal. Isothermals of 4-component Na–K glasses depending on composition have a 100-fold maximum for atomic concentrations of K and Na 1 : 1. Conductivity of 4-component glass containing 2 alkali-oxides equals in a first approximation the sum of the

conductivities of two 3-component glasses, each of which contains one alkali-oxide in the same concentration as in the actual 4-component glass.

B. F. KRAUS

537.311.33 : 535.343.2–14

1640. New method for the study, by high frequency spectroscopy, of defects in the structure of the semiconductor ZnO. M. FREYMANN AND R. FREYMANN. Letter in *J. Phys. Radium*, **13**, 589–90 (*Nov.*, 1952) *In French.*

Debye absorption can be attributed to dipoles arising from either molecular orientation or lattice defects. Experiments on ZnO show the presence of Debye absorption, that ionic conduction occurs above 225°K, and that the activation energy for defects is 0·28 eV for treatments at 1190°C, and 0·19 for 1100°. From the results the i.r. oscillator frequencies may be determined and ultimately the concentration of structural defects. C. A. HOGARTH

537.311.33 : 537.226.3

The new method of studying lattice defects in solids by Debye absorption: case of semiconductors. *See Abstr.* 1623

537.311.33 : 537.312.5

1641. Electrical and optical properties of boron. J. LAGRENAUDIE. *J. Phys. Radium*, **13**, 554–7 (*Nov.*, 1952) *In French.*

The low-temperature semiconduction of boron indicates activation energies of 0·06, 0·3, 0·4 and 0·6 eV for the impurity levels. The last three values are obtained on the basis of the Wilson model; the first is attributed to hydrogen-like impurities and is assumed to be associated with the dielectric constant of 14 for boron. *P*-type conduction is found with low mobility and photoconductivity measurements fix the lattice energy band separation as 1·2 eV.

G. F. J. GARLICK

537.312

1642. Mobility in high electric fields. E. M. CONWELL. *Phys. Rev.*, **88**, 1379–80 (*Dec.* 15, 1952).

An extension of conductivity theory to high fields, subject to the usual simplifying assumptions, is carried out for the cases in which the change of energy of an electron in a collision can be neglected. This yields a relationship between mobility and relaxation time which is valid over a wide range of fields. A.

537.312

1643. Problem of the dependence of the high-voltage polarization of dielectrics on the electric field strength. V. A. PRESNOV. *Zh. tekh. Fiz.*, **22**, *No.* 6, 955–60 (1952) *In Russian.*

Measurements of the conductivity of dielectrics during various short time intervals (10^{-4}, 6×10^{-4}, 10^{-3} sec) show that a fall of the current in time and thus the setting up of space charges takes place in natural rock salt crystals even at very high field strengths of the order 200 kV/cm. In glasses this phenomenon depends on their composition. Deviations from Ohm's law are due to 2 effects: (1) the relative diminution of the e.m.f. of polarization at high compared with low voltages; (2) an increase of the "true" electrical conductivity of the dielectric. The latter phenomenon may in the case of ionic dielectrics be due to 2 causes: (1) the emergence of the electronic current component; (2) an increase of the ionic component of the conductivity which is determined as $\sigma_i = \overline{A}_i \exp(-\overline{U}_i/2kT)$ where the activation energy $\overline{U}_i$ is practically independent of the field strength. At a field strength determined by $2e\sqrt{eE/\varepsilon} = U_0 - \overline{U}_i$ the ionic dielectric assumes electronic character. For NaCl, $U_i \sim 2$ eV, $\overline{U}_0 \sim 7{\cdot}7$ eV. The electronic component becomes conspicuous at field strengths $E > 10^6$ V/cm. This means that Frenkel's mechanism of the increase of the conductivity of dielectrics applies only at strong fields. At lower field strengths ($\sim 10^5$ V/cm) Ioffe's mechanism is more likely to correspond to facts. For glasses the conductivity is purely ionic up to breakdown stresses. B. F. KRAUS

537.312.6

1644. The temperature dependence of electrical resistance. W. V. HOUSTON. *Phys. Rev.*, **88**, 1321–3 (*Dec.* 15, 1952).

The electrical resistance of a simple metal can be computed over a wide range of temperature by considering the thermal vibrations and the scattering from individual ions. Observations by MacDonald and Mendelssohn make possible a comparison with experiment from room temperature down to very low values. Moderate agreement for Li and Na can be obtained by a suitable choice of parameters, but the values necessary are not in close agreement with those suggested by other phenomena. An approximate method for taking into account all three normal modes of vibration with a given propagation vector also gives moderate agreement with the observations. A.

537.312.62

1645. On the destruction of superconductivity by large currents. C. G. KUPER. *Phil. Mag.*, **43**, 1264–75 (*Dec.*, 1952).

A theoretical study is made of the restoration of resistance in superconducting wires by large currents. The experiments of Shubnikov and Alexeevsky and of Scott show a marked deviation from the theory of F. London. The present theory uses the same geometrical model of the structure as London, i.e. a string of superconducting conical domains along the axis of the wire. But it takes account of the effect on the resistance of the scattering of electrons at successive normal superconducting interfaces, when their separation is comparable to the mean free path of the electrons in the normal phase. The scale of the structure is determined by minimizing the "Magnetic Gibbs' Function." It is shown that the interfacial surface energy may be neglected. The theory is in fair agreement with the rather scanty experimental data. The only parameter of the theory is the mean free path of electrons, and the value assigned is consistent with that obtained from other phenomena. A.

537.312.62

1646. Measurements in the transition region to superconductivity. III. W. MEISSNER, F. SCHMEISSNER AND H. MEISSNER. *Z. Phys.*, **132**, *No.* 5, 529–43 (1952) *In German.*

For Pt II, see Abstr. 1807 (1952) [which requires correction, as follows: penultimate line, for j read γ;

last line, add "if H is measured in amp/cm"]. Rod-shaped Sn and Hg specimens were used, which show in the transition region an increase of the flux produced by a longitudinal magnetic field above its value in the normal state if an electric current passes through the rod. The time variation of the flux on switching on and off or commutating the magnetic field is studied. Further experiments concern hollow cylinders of Hg. These show an increase of flux also in the cavity as long as the specimen is in the transition range. When the specimen has reached the superconducting state by cooling the final flux in the cavity is again normal. These experiments prove that the increased flux is due to a macroscopic circular current and not to a volume magnetization. Slotted hollow cylinders show no supernormal flux, not even in body of the specimen. The same is true for a slotted solid cylinder. Comparison of the slotted and non-slotted specimens show that the maximum flux in the latter occurs when, with falling temperature, the already formed superconducting regions begin to grow together. After this the whole specimen becomes superconducting within a very small temperature interval. These results are in agreement with observations on the change in resistance in Abstr. 1807 (1952). Finally some not very pure Ta-rods have been investigated. With these the increase in flux was only 1/10 of that found in Hg.

H. LONDON

537.312.62 : 536.21

1647. Heat conductivity of superconductive lead below 1°K. J. L. OLSEN AND C. A. RENTON. *Phil. Mag.*, **43**, 946–8 (*Sept.*, 1952).

This was determined between 0·4° and 1·16°K by measuring the temperature by carbon resistors at two intermediate places along a single crystal specimen, which was electrically heated at one end and cooled at the other end by a paramagnetic salt. Below 1°K the results can be represented by $\kappa = 0{\cdot}09_2 T^3$ watt/degree cm. Measurements in the intermediate state again show a minimum of thermal conductivity [see Abstr. 1020 (1952), which should be corrected by replacing "higher" in line 4 by "lower"; see also Abstrs. 2705 (1951), 6525 (1952)].

H. LONDON

537.312.9

1648. The effect of temperature of deformation on the electrical resistivity of cold-worked metals and alloys. T. BROOM. *Proc. Phys. Soc.* [*London*] *B*, **65**, 871–81 (*Nov.*, 1952).

A special apparatus has been used to draw wires of various metals at temperatures between −183°C and 100°C, and to measure their resistances at the temperature of drawing. The change of restivity with deformation was found to depend on the temperature of deformation relative to the recrystallization temperature. The results explain qualitatively the apparently anomalous resistivity increases previously reported for tungsten and molybdenum. It is suggested that a unified theory of the effect of deformation on the resistivity of both pure metals and alloys can be based on stacking faults. A.

537.321

1649. A critical study of the asymmetrical temperature gradient thermoelectric effect in copper and platinum. N. FUSCHILLO. *Proc. Phys. Soc.* [*London*] *B*, **65**, 896–904 (*Nov.*, 1952).

A method is described by which metallic wires can be subjected to easily measurable but very pronounced asymmetrical temperature gradients without straining the wire. The electromotive forces developed by the application of symmetrical and asymmetrical gradients to annealed "thermopure" Pt wire and specially prepared cables of Cu wire, at both high and low temperatures, have been measured at many points along considerable lengths of wire. Precautions to minimize or eliminate spurious effects enabled measurements significant to 0·01 μV to be taken. The results provide no justification for the supposition that an asymmetrical temperature gradient thermoelectric effect exists, under the conditions of investigation, which cannot be explained in terms of inhomogeneity effects. The nature of these effects is discussed and some evidence is provided which indicates that the variation in the Thomson thermoelectric potential with strain and impurity is significant. A.

537.323 : 538.639

1650. On the magneto-thermoelectric power of iron crystal at low temperatures. Y. GONDÔ AND Z. FUNATOGAWA. *J. Phys. Soc. Japan*, **7**, 589–92 (*Nov.–Dec.*, 1952).

The magneto-thermoelectric power of iron single crystal was measured in a temperature region between room temperature and −195°C and the anisotropic constants $(E_m)_{100}$ and $(E_m)_{111}$ (which specify the effect along the direction [100] and [111], respectively) were calculated, at various temperatures. From these results and those at high temperatures reported in Abstr. 7301 (1952) both the constants $(E_m)_{100}$ and $(E_m)_{111}$ were found to have maximum values near room temperature and decrease gradually with decreasing temperature, perhaps tending to zero at 0°K. A.

537.36 : 536.7

1651. Nonequilibrium thermodynamics of the sedimentation potential and electrophoresis. S. R. DE GROOT, P. MAZUR AND J. T. G. OVERBEEK. *J. chem. Phys.*, **20**, 1825–9 (*Dec.*, 1952).

The thermodynamics of irreversible processes is developed for a system placed in a centrifugal field and consisting of a number of components, some of which carry electrical charges. It is found that an Onsager reciprocal relation connects the sedimentation potential with a quantity called by the authors barycentric electrophoresis (i.e. the quotient of the total mass flow and the electrical field at zero centrifugal field). The latter quantity turns out to be ordinary electrophoresis in a colloid (i.e. in a system of one neutral and a number of charged components, one of which consists of colloidal particles) under certain limiting, but frequently realized, circumstances. If conduction relaxation exists, it appears in both connected phenomena described here. A.

537.362

1652. Streaming potential and electro-osmosis. *Nature* [*London*] **170**, 836–7 (*Nov.* 15, 1952).

A model for the mechanism of streaming potential. H. E. ROSE AND G. MOSS (836–7). The model proposed in the first paper is based on the postulates that the radial distribution of charge varies smoothly

along a capillary under steady-flow conditions and that there is no circulation of ions within the fluid. The implications of these postulates are discussed and several results of a detailed analysis are given. Among the phenomena that can be accounted for are streaming potential, electro-osmosis, cataphoresis, sedimentation potential, the conductivity used in place of the bulk conductivity in the classical equation, pressure effects due to electro-osmosis, deviations from Darcy's law and possibly flocculation and dispersion.

Mechanism of electro-osmosis. K. L. NASH AND N. W. LISTER (837). Electro-osmosis is discussed and an experimental investigation of the electro-osmotic flow of water through a bed of quartz powder subject to potential gradients of up to 40 volts/cm is briefly described. The results are shown to be in agreement with the theory. M. R. HOPKINS

ELECTRIC DISCHARGES 537.52

537.521.7 : 621.3.015.5

1653. Contribution to the theory of impulse breakdown. F. R. DICKEY, JR. *J. appl. Phys.*, **23**, 1336–9 (*Dec.*, 1952).

The experiments of R. C. Fletcher on impulse breakdown are discussed and a simple theory for these experiments is developed by assuming that the breakdown consists of ionization and charge separation in a uniform field. The theory accounts reasonably well for the time lags and also explains the shapes of the breakdown voltage transients. It indicates also that measurement of the mean ionizing time for electrons in the gap should be possible. A.

537.523 : 621.3.014.31

1654. On bridging between copper electrodes in a nitrogen discharge. H. PUPKE. Note in *Naturwissenschaften*, **39**, *No.* 18, 426–7 (1952) *In German.*

Briefly describes the formation of metallic protuberances at electrodes in a.c. discharges, which eventually form a bridge across the discharge gap. A photograph of the phenomenon is included.

J. D. CRAGGS

537.525

1655. Collisional processes and similarity in high frequency discharges in helium. F. LLEWELLYN JONES AND G. C. WILLIAMS. *Proc. Phys. Soc.* [*London*] *B*, **66**, 17–24 (*Jan.*, 1953).

The validity of the similarity theorem for high frequency discharges in helium is examined experimentally in non-uniform fields over a range of frequencies f from 5 to 70 Mc/s and gas pressure p from 1 to 30 mm Hg. The theorem is satisfied for similar discharge systems in pure helium but not when traces of impurity are present. The theorem is shown to be sensitive not only to changes in the parameters pa and f/p, where a is a linear dimension of the discharge tube, but also to changes in the purity of the gas when the impurity can introduce collisional processes which are not dependent on X/p. The failure of the theorem for impure helium for similar discharge systems is accounted for by the occurrence of collisions of the second kind between metastable atoms of helium and molecules of impurity. A.

537.525.3 : 537.525.72 : 537.525.8

1656. Positive and negative Joshi effect in a.c. "silent" discharges in iodine vapour. S. R. KHASTGIR AND P. S. V. SETTY. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 823–4 (*Oct.*, 1952).

Shows oscillograms taken with an iodine vapour ozonizer tube, and gives a general discussion of them.

J. D. CRAGGS

537.525.3 : 621.3.015.532

1657. The mechanism of the ring discharge in negative point-to-plane corona. A. GREENWOOD. *J. appl. Phys.*, **23**, 1316–19 (*Dec.*, 1952).

Conditions favouring the formation of the ring discharge, and changes in the electrical characteristics which it brings about, are discussed. A theory is developed which seeks to explain the formation of the ring in terms of field distortion caused by negative space charges in the gap. This requires a change of view on the subject of space charge transit times, but this is justified by theoretical and experimental considerations. The paper concludes with a description of two experiments designed to test the theory, and analyses the results of these tests. A.

537.525.5

1658. Oscillatory phenomena of arc in hot cathode discharge tube. I. Experimentals (characteristics of oscillation). H. YOSIMOTO. *J. Phys. Soc. Japan*, **8**, 59–68 (*Jan.–Feb.*, 1953).

The oscillatory phenomena are observed in a hot cathode discharge tube like a fluorescent lamp. The oscillations occur in the vicinity of the anode, and are the periodic variation of the anode fall accompanied by a sudden ionization. The characteristics of the oscillations depend on the anode conditions as well as the thermionic emissivity of the cathode. A.

537.525.5

1659. Oscillatory phenomena of arc in hot cathode discharge tube. II. Theoretical (mechanism of oscillation). H. YOSIMOTO. *J. Phys. Soc. Japan*, **8**, 69–76 (*Jan.–Feb.*, 1953).

The oscillations occur in the following cases: (1) the quantity of the positive ions generated by ionization in the anode fall is greater than that necessary to sustain the arc, and (2) the arc current is smaller than the saturated electron current determined by the cathode temperature. Accordingly the existence of the excess ions is the cause of the oscillations. Ionization and diffusion occur alternately. Therefore the characteristic of oscillation is determined by the quantity of excess ions. But in this case it is also influenced by the space charge in front of the cathode, that is, by the thermionic emission of the cathode. And generally a fraction of the excess ions will be employed to reduce the anode fall, if the electron emission becomes limited by its saturation value or by the negative space charge in front of the cathode. A.

537.525.5 : 536.24 : 621.314.65

1660. Pool surface and cathode spot temperature of mercury cathodes as a problem in heat conduction. R. TUCKER; H. VON BERTELE. Letters in *Brit. J. appl. Phys.*, **3**, 333 (*Oct.*, 1952).

See Abstr. 4373 (1952). Briefly discusses certain

aspects of the cooling, by air or water, of the cathodes of mercury arc devices with reference to temperature gradients across the cooling air stream. J. D. CRAGGS (R)

537.525.8

1661. The direct current associated with microwave gas discharge between coaxial cylinders. I. K. MITANI. *J. Phys. Soc. Japan*, **7**, 634–6 (*Nov.–Dec.*, 1952).

The author has found that when microwave gas breakdown occurs, direct current flows, without application of any direct voltage, in the external circuit from the outer conductor to the central wire of a cylindrical cavity containing gas. An attempt has been made to explain this phenomenon by use of the diffusion theory of Herlin and Brown. The electron diffusion current density potential has been determined and thence the maximum electron density has been derived. A.

537.525.8

1662. The direct current associated with microwave gas discharge between coaxial cylinders. II. K. MITANI. *J. Phys. Soc. Japan*, **7**, 637–9 (*Nov.–Dec.*, 1952).

Once microwave gas breakdown has occurred, the microwave gas discharge continues even at lower power and at the same time direct current continues to flow, without application of any direct voltage, in the external circuit. From the observation of the length of the microwave glow appearing along the axis of the cylindrical cavity, the direct current J has been shown to be proportional to E and nearly inversely proportional to P, where E is the maximum value of the microwave electric field intensity and P the gas pressure. A.

537.525.8 : 535.33.03

1663. Infrared molecular emission excited in a glow discharge. R. M. TALLEY, D. S. LOWE AND W. W. SCANLON. Letter in *J. Opt. Soc. Amer.*, **42**, 982–3 (*Dec.*, 1952).

Reports the observation of near infrared radiation (~2000–10 000 cm^{-1}) from glow discharges in various gases, notably CO_2, at pressures ~several cm Hg. Other gases tried were: methane, ethane, propane, propylene, water vapour and air. J. D. CRAGGS

537.525.8

1664. Electrical fields in the Crookes dark space of a low pressure glow discharge in air and N_2. R. P. STEIN. *Phys. Rev.*, **89**, 134–42 (*Jan.* 1, 1953).

Application of a 20 000 V electron beam probe to the study of the fields in the Crookes dark space of normal and abnormal glow discharges in air and N_2 from 50 to 400 microns pressure and current densities from 3 to 20 $\mu a/cm^2$ were made. In general agreement with Aston's low pressure study of 1911, the fields generally dropped in a linear fashion from cathode to negative glow. Fields ranged from 600 V/cm on down at the cathode. Over-all accuracy was 10% or better. These fields, together with known variations of ion drift velocity and approximate Townsend second coefficients γ, allow the ionization per cm along the axis to be computed as a function of position in the dark space. While accuracy of fields at the cathode are not such as to allow of positive statement, the nature of errors present strongly indicate the ionization function in the dark space to be of the type deduced by Morton under similar conditions in coaxial cylindrical geometry. A.

537.525.8

1665. Enhancement of the green continuum of Hg by a rare gas. C. KENTY AND D. A. LARSON. *Phys. Rev.*, **89**, 180–1 (*Jan.* 1, 1953).

The green continuum of Hg vapour in a low current, positive column discharge has been found to be greatly enhanced by the presence of a considerable pressure of a rare gas (e.g. 50 mm A). The effect is mostly striking for lower Hg pressures (e.g. at 50°c). At 215°c the light efficiency of the continuum reaches 41 lu/W. The continuum extends from 4000 to 6400Å; its maximum occurs at 5130Å at 115° and shifts toward the violet at higher temperatures. Very small amounts of gas impurity, e.g. 40 parts per million of N_2 increase the brightness and also the voltage; larger amounts, e.g. 150 ppm N_2, quench the brightness almost completely. A.

537.525.8.

1666. Probe measurement for high frequency discharge. III. S. KOJIMA, K. TAKAYAMA AND A. SHIMAUCHI. *J. Phys. Soc. Japan*, **8**, 55–69 (*Jan.–Feb.*, 1953).

For Pt II, see Abstr. 1864 (1951). A method for determining the electron temperature and the field strength of h.f. plasmas is given. It is a modified floating double probe method, where the double probe consists of a rod probe and a forked probe. By this method A discharges in the region between 0·26 and 1·0 mm Hg at 170 Mc/s have been studied. The electron temperatures and the field strengths were measured as a function of the radius of discharge tubes and compared with theoretical equations. The obtained results were approximately equal to those of d.c. discharge. A.

537.525.8 : 621.385.1.029.6

1667. Observations on the effect of plasma oscillations in transit time tubes. F. LÜDI. Note in *Z. angew Math. Phys.*, **3**, *No.* 5, 390–3 (1952) *In German.*

A brief theoretical paper on the effects of plasma oscillations in the klystron and in the interaction space of travelling wave tubes. It is concluded that, for the latter case, plasma oscillations have no effect.

J. D. CRAGGS

537.525.9 : 538.566

1668. Electromagnetic properties of plasmas. M. BAYET. *J. Phys. Radium*, **13**, 579–86 (*Nov.*, 1952) *In French.*

Discusses the propagation of longitudinal and transverse e.m. waves in ionized gases, for the special case of negligible magnetic field. Electron mobilities and dispersion formulae are studied in detail. The paper is theoretical but gives 36 references to other theoretical and experimental work on the subject.

J. D. CRAGGS

X-RAYS 537.531

537.531

1669. The X-ray spectrum from a 70 MeV synchrotron. I. B. MCDIARMID. Letter in *Phil. Mag.*, **43**, 1003–5 (*Sept.*, 1952).

Forward X-rays from a $\frac{1}{4}$ in. dia. tungsten rod

produced 637 electron pairs in nuclear plates. Results agreed with Schiff's theory [Abstr. 7020 (1951)] above 25 MeV; below, the observed photons were considerably fewer. F. R. HOLT

537.531

1670. The inherent half-width of *K*-conversion lines. H. Slätis and G. Lindström. Letter in *Phys. Rev.*, **88**, 1429 (*Dec.* 15, 1952).

Measurements are reported showing that *K*-conversion lines of ThB are about 80 keV broader than *L* lines. The effect is attributed to the short lifetime of the accompanying *K* α-radiation. J. J. WILKINS

537.531

1671. Bremsstrahlung cross section of 60-MeV electrons in lead. C. D. Curtis. *Phys. Rev.*, **89**, 123–30 (*Jan.* 1, 1953).

Sixty-MeV electrons from a pulsed betatron passed through lead foils of thicknesses 0·001, 0·005 and 0·015 in. placed in a magnetic cloud chamber. Measurements of approximately 1100 large energy losses gave the differential bremsstrahlung cross-section as a function of X-ray energy for the high-energy portion of the X-ray spectrum. Corrections were applied for instrumental discrimination and for multiple radiation and ionization energy losses in the foils. While the shape of the top 30% of the X-ray spectrum agreed with the theory within experimental uncertainty, the magnitude of the cross-section was about 7% lower than theory. A.

537.531 : 535.338.1 : 535.343

1672. Theory of the X-ray absorption and emission spectra in ionic crystals. A. I. Kostarev. *Zh. eksper. teor. Fiz.*, **22**, *No.* 5, 628–35 (1952) *In Russian.*

A comparison of the fine structure of the *K*-bands of X-ray absorption of an ionic crystal (e.g. KCl) with the system of its optical levels shows a satisfactory agreement between the two spectra. A further comparison with the *K*-series of the X-ray emission spectrum furnishes a new interpretation of the short-wave $K\beta$ satellite of this spectrum. B. F. KRAUS

537.531 : 535.343

1673. X-ray transition probabilities with special reference to *K* absorption in lithium. J. Friedel. *Phil. Mag.*, **43**, 1115–39 (*Nov.*, 1932).

To interpret the position of X-ray absorption edges in monovalent metals, the author assumed in a previous paper [Abstr. 3758 (1952)] that the positive hole created in an inner shell was screened by a bound electron. It is shown here that this assumption gives also a correct order for the magnitude of the absorption coefficient near the edge. In an introductory treatment the absorbing system is taken to be the ejected electron alone. The hydrogenic wave-function for the bound state and the plane wave for the continuum is used. Approximate formulae are thus obtained for the total jump in the absorption coefficients at the *K*, *L* and *M* edges, both for X-rays and in the optical region. In a further treatment, taking Li as an example, the absorbing atom and the Fermi electrons are treated as a whole, and with this model the fine structure of the edge is analysed. It is shown how the screening may be obtained from the conduction band. Various possible types of transitions producing edges or lines in the absorption are analysed, and related to the structure observed near the edge. To avoid too much complexity in treating the Fermi electrons, the metal is enclosed in a large but finite sphere. Quantitative agreement with experiment is not altogether satisfactory, possibly because of inaccuracies in the wave-functions used. The reverse process of *K*-emission in Li is described, and the possible presence discussed of lines as well as bands in the X-ray spectra of monovalent metals. A.

537.531 : 535.433

1674. Interference effects in the small angle scattering of X rays by small particles. G. E. Noakes and E. J. Allin. *Canad. J. Phys.*, **31**, 40–8 (*Jan.*, 1953).

Interparticle interference effects have been observed in the small angle X-ray scattering from 30 samples prepared by the evaporation of gold colloids containing spherical particles of uniform size. The position of the interference maximum was found not to be the same for all samples containing particles of the same size. Calculation verifies that the position of this maximum is dependent on the radial distribution of the particles. It cannot be used for size determinations unless this distribution is known. The predicted variation of the slope at small angles of the ln *I v.* k^2 curve with particle distribution was confirmed experimentally. This method of size determination is unsatisfactory whenever interference effects are present. It is suggested that size determinations based on the positions of the form function maxima are almost independent of particle distribution even in concentrated samples. A unique determination of the particle distribution from the position and shape of the interference maximum would appear to be impossible even if the size were known. A.

537.531 : 548.733

Fine-focus X-ray tubes for X-ray structural analysis. *See Abstr.* 2065–72

537.531 : 621.386.77

1675. Non-uniform filter to produce a flat isodose surface of roentgen-ray intensity. M. A. Greenfield and K. Hand. *Amer. J. Roentgenol.*, **68**, 950–3 (*Dec.*, 1952).

An example of an empirically constructed filter for a 250 kV X-ray tube. F. T. FARMER

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533.72

1676. Spherical aberration of gridded lenses. M. Bernard. *C.R. Acad. Sci.* [*Paris*] **235**, 1115–17 (*Nov.* 10, 1952) *In French.*

The aberration coefficient is calculated for the approximation of a continuous membrane, transparent to electrons. The coefficient is positive for converging lenses and negative for diverging lenses.

A. H. W. BECK

537.533.72

677. Calculation of the potential distribution on the xis of an electrostatic immersion objective with thick lectrodes. A. SEPTIER. *C.R. Acad. Sci.* [*Paris*] **235,** 203–6 (*Nov.* 17, 1952) *In French.*

Expressions for the potential, derived by two ifferent methods, are given and are compared with he correct distribution. A. H. W. BECK

537.533.72

678. On the determination of the electron optical haracteristics of electrostatic lenses. W. LIPPERT AND V. POHLIT. *Optik*, **9,** *No.* 10, 456–62 (1952) *In erman.*

Deals with the electrostatic "eigenlinse." Experimentally determined curves giving the focal length nd position of the principal planes are given, as re the conditions which the lens geometry must bey for achromatic correction. A. H. W. BECK

537.533.72

679. An electron diffraction instrument. R. S. PAGE ND R. G. GARFITT. *J. sci. Instrum.*, **29,** 398–401 *Dec.*, 1952).

The electron optical requirements for the production f electron diffraction patterns are discussed and it is hown that the resolving power is a function of the ize of the electron source. A new production instrument is described which has been designed for general daptability and simplicity of operation. A thermionic self-biased electron gun provides a source of mall dimensions, the beam from which is focused at he recording plane by a magnetic electron lens. Numerous ports are provided in the body of the nstrument to allow for special modes of operation. Beam accelerating voltages up to 100 kV are supplied rom a high frequency d.c. set. Some typical electron iffraction patterns are shown. A.

537.533.72 : 621.385.833

680. A method for the measurement of spherical berration of an electrostatic electron lens. D. W. HIPLEY. *J. appl. Phys.*, **23,** 1310–16 (*Dec.*, 1952).

A relatively simple method for the experimental letermination of spherical aberration of electrostatic lectron lenses is described. This method uses an ffective point source of electrons at the centre of leflection of a magnetic deflection yoke; the yoke leflects the beam through any desired aperture angle. From the measurement of the displacement of the lectron-beam in the Gaussian image plane as a unction of the aperture angle, the coefficient of pherical aberration can be calculated. The value for his coefficient obtained from the measurement of a inipotential lens and that calculated for this lens by umerical integration are compared; the agreement s within 12%. An effective method for the detection f axial astigmatism (which is due to an ellipticity of he lens field) of a lens is described. Diagrams and hotographs are given which qualitatively substantiate the method. A.

537.533.72 : 621.385.833

681. On the Stigmator of the electron microscope. . RECKNAGEL AND G. HAUFE. *Wiss. Z. Tech. Iochsch. Dresden*, **2,** *No.* 1, 1–10 (1952–53) *In German.*

The Stigmator is the name given to a device for correcting astigmatism in an electron microscope. It consists of a cylinder composed of longitudinal metallic segments, insulated from each other, which is placed behind the objective. The Stigmator is centred by electron optical means and by a suitable choice of potential on the segments the desired correcting field may be obtained. The application of the device to a Zeiss 3-stage electrostatic microscope is described. J. THEWLIS (R)

537.533.74

1682. Investigations on positron-electron scattering. R. R. ROY AND L. GROVEN. *Phil. Mag.*, **43,** 1291–6 (*Dec.*, 1952).

The scattering of positrons by electrons has been studied in N by a cloud-chamber method. In 6000 photographs 5600 positrons were measured, giving a total track length of 792 metres between the energies 0·5 MeV and 1·1 MeV. The experimental results, when compared with the exchange theory of Bhabha, show satisfactory agreement. A.

537.533.8 : 771.534

1683. Beta- and gamma-induced Cerenkov radiation in water. M. A. GREENFIELD, A. NORMAN, A. H. DOWDY AND P. M. KRATZ. *J. Opt. Soc. Amer.*, **43,** 42–3 (*Jan.*, 1953).

The spectral energy distribution of radiation from water bombarded by radium γ-rays or P^{32} β-rays is that expected for Cherenkov radiation. A solution of P^{32} in water furnishes a source of Cherenkov radiation which is convenient for the determination of the spectral sensitivity of photographic emulsions. A.

537.534 : 621.319.339 : 621.384.62

1684. A converted electron accelerator to produce 2·3 MeV positive ions. R. W. LAMPHERE AND G. P. ROBINSON. *Nucleonics*, **10,** 28–31 (*Oct.*, 1952).

The accelerator described is a Van de Graaff generator, originally designed as an electron generator and converted to give a 100 μA beam of magnetically analysed protons. Details of the r.f. ion source and its associated equipment, the accelerating tube (in which particular attention is paid to shielding the glass walls from the beam and preventing electron multiplication), the pumping system (where efficiency in pumping hydrogen has been an important consideration) and the method of beam energy control are given. L. R. SHEPHERD

537.534 : 621.384.611

1685. Synchrocyclotron for 450-MeV protons. H. L. ANDERSON, J. MARSHALL, L. KORNBLITH, JR, L. SCHWARCZ AND R. MILLER. *Rev. sci. Instrum.*, **23,** 707–28 (*Dec.*, 1952).

A 170 in. synchrocyclotron recently completed at the Institute for Nuclear Studies, The University of Chicago, is described. It is capable of accelerating protons to an energy of 450 MeV, deuterons to an energy of 256 MeV and α-particles to an energy of 512 MeV. The magnet poles are especially contoured to give a field of 18 600 gauss in the centre decreasing to 17 600 gauss at radius 76 in. The radiofrequency is modulated by means of a rotating condenser in a three-quarter wave resonant line oscillator. A circulating beam of about one microampere of

450 MeV protons is normally obtained. This beam falling on an internal beryllium target produces about 4×10^{10} π-mesons per sec. Some of these π-mesons emerge from the cyclotron, pass through channels in a heavy shield and are available in well-collimated beams, well-defined in energy. The present beams range in energy from 66 MeV to 230 MeV for π^- mesons and from 66 to 145 MeV for π^+ mesons. In the external 122 MeV π^- beam there are $1000\pi^-$ mesons per cm² per sec available over an area of about 50 cm² at 20 ft from the target. The energy spread is about ±4 MeV. A.

537.534 : 621.384.611 : 621–526

1686. A servomechanism for the elimination of time lag. R. L. GARWIN. *Rev. sci. Instrum.*, **23**, 681–3 (*Dec.*, 1952).

A servomechanism is developed to eliminate the time constant caused by thermal capacity and resistance in the measurement of power to a cyclotron target by thermocouple measurements. An analysis by the Laplace transform method shows that the observed reduction of the time constant from 300 sec to 12 sec is to be expected from the components of the system. A.

537.534.72

1687. On aberrations in mass spectrometers with magnetic sectors. L. MUSUMECI. Note in *Nuovo Cimento*, **9**, 429–35 (*May*, 1952) *In Italian.*

In a previous article [Abstr. 8050 (1950)] some cases of flat focusing of the 1st and 2nd order were examined in the condition of the maximum dispersion of the images. A more general proceeding of the calculation of the aberration is shown in the present work. The values of aberration and distribution density along the collector plate, are calculated up to an initial 20° divergence of the tracks. This calculation is made for 1st and 2nd order focusing. The advantage of the polar cylindrical expansions is set forth in comparison with other geometrical dispositives. A.

537.534.72 : 621.319.339 : 621.384.62

1688. A versatile focusing system for Van de Graaff accelerating tubes. P. HOWARD-FLANDERS. *Nature* [*London*] **170**, 744–5 (*Nov.* 1, 1952).

A focusing system is described which uses the lens formed by an aperture in a diaphragm separating two regions of uniform but differing field strengths. The earlier field is the lower, and curves are given showing how the length and voltage ratios between the two fields must be related to focus particles on a given target. The satisfactory performance of this system when used with a 2 MeV Van de Graaff generator is described. J. H. FREMLIN

537.534.74

1689. Elastic scattering of protons and neutrons by helium. D. C. DODDER AND J. L. GAMMEL. *Phys. Rev.*, **88**, 520–5 (*Nov.* 1, 1952).

Proton-α-elastic scattering experiments at 5·81 and 9·48 MeV are analysed in terms of phase shifts, and the results, together with earlier ones at lower energies, are used to compute the logarithmic derivatives of the wave functions at a radius of $2{\cdot}9\times10^{-13}$ cm. These logarithmic derivatives, for $P_{1/2}$ and $P_{3/2}$ states, are found to be linear functions of the energy. From the behaviour of the logarithmic derivatives the widths and positions of the $P_{1/2}$ and $P_{3/2}$ energy levels are determined, the most striking results being the large splitting of the two levels and the very broad width of the $P_{1/2}$ level. These results are compared with neutron-α-experiments and are found to be in sufficiently good agreement to support the conclusions about the $P_{1/2}$ level which differ from those previously expected. Small negative D wave phase shifts are found in the proton-α-experiments which also show evidence of an inverted doublet spin-orbit splitting. A.

537.534.74

1690. Proton-deuteron scattering at 5·1 MeV and deuteron-proton scattering at 10·2 MeV. K. B. MATHER. *Phys. Rev.*, **88**, 1408–11 (*Dec.* 15, 1952).

A photographic scattering chamber has been used to study the elastic scattering of 5·1 MeV protons by deuterium and 10·2 MeV deuterons by hydrogen, these being the same process in the centre-of-mass system. Differential cross-sections were obtained from 16·4° to 172·9°. These are in good agreement with other experimental data at about the same energy. Comparison is made with the theoretical angular distribution due to Buckingham, Hubbard and Massey, based on a symmetrical exchange force. Agreement is close at this energy, favouring exchange rather than ordinary force theories. However, at higher energies ($\sim$10 MeV $p-d$) the B.H.M. calculations do not represent the interaction satisfactorily. A.

537.534.74

1691. Angular dependence of inelastic scattering of protons on Be^9. K. E. DAVIS. Letter in *Phys. Rev.*, **88**, 1433 (*Dec.* 15, 1952).

The angular distribution of protons from $Be^9(p,p')Be^{9*}$ (2·4 MeV level) has been measured from 20° to 160°, using a nuclear plate camera and 7·1 MeV incident protons. The distribution is essentially isotropic from 60° to 160° but increases sharply towards the smaller angles. The increase is tentatively attributed to inelastic Coulomb scattering. J. J. WILKINS

537.534.74

1692. The elastic scattering of protons from helium 4. B. CORK. *Phys. Rev.*, **89**, 78–9 (*Jan.* 1, 1953).

The absolute differential cross-section has been measured for 31·6 MeV protons scattered elastically from He. Seven increments of angles from 15° to 51° in the laboratory system of co-ordinates have been measured simultaneously, using proportional counters. The observed nuclear scattering is approximately three times the calculated Rutherford scattering for a scattering angle of 17° in the centre-of-mass system and approximately 100 times the calculated Rutherford scattering for an angle of 62° in the centre-of-mass system. Also, the differential cross-section for a centre-of-mass angle 55° has been observed to be 59·1 millibarns/steradian for incident protons of 19·5 MeV in the laboratory system. A.

537.534.8

1693. Electron ejection from Mo by He^+, He^{++}, and He_2^+. H. D. HAGSTRUM. *Phys. Rev.*, **89**, 244–55 (*Jan.* 1, 1953).

Total yield and kinetic energy distribution have

been measured for electrons ejected from atomically clean and gas-covered Mo by the ions He^+, He^{++}, and He_2^+ in the kinetic energy range 10 to 1000 eV. Evidence is presented that one electron is excited into the kinetic energy continuum for each incident He^+ ion and that the electrons so excited are partially internally reflected at the potential barrier of the metal. The slowest ions observed were found to eject 0·25, 0·72 and 0·13 electron per ion for He^+, He^{++} and He_2^+, respectively. Total electron yield is found to be nearly independent of ion kinetic energy up to 1000 eV. This observation and that of the kinetic energy maximum for slow ions indicate that the electrons are released in an Auger type process for which the energy is supplied by the potential and not the kinetic energy of the ion (potential ejection). Electrons of kinetic energy greater than the upper limit predicted by present theory are observed for faster ions and are accounted for by the shift of the energy levels of the bombarding particle when it is near the metal surface. Some conclusions concerning reflection processes at a metal surface and the nature of electron ejection by the α-particle (He^{++}) and the molecular He ion (He_2^+) come out of this work. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542

1694. A new extraction principle for ion sources: applications to different types of sources. J. SOMMERIA. Letter in *J. Phys. Radium*, **13**, 491 (*Oct.*, 1952) *In French.*

Describes a modified extractor system for ion sources in which field penetration, from the first focusing electrode of the accelerator system into the plasma, is made effective over a greater area than usual. It was applied to sources of the well-known types described by Heil and Finkelstein. J. D. CRAGGS

537.542

1695. An investigation on Geiger–Müller counters with X-ray impulses. P. MÜLLER. *Ann. Phys.* [*Leipzig*] **11**, *No.* 2–3, 175–80 (1952) *In German.*

Using short X-ray pulses, various discharge phenomena in Geiger counters were studied. The dead-times and recovery periods were measured, for example, with double X-ray pulses separated by a known time, and the paper is illustrated with oscillograms which are unusually clear. Multiple pulses in the proportional region are also shown. J. D. CRAGGS

537.542

1696. On counter tubes with methylene halide vapour fillings. H. NEUERT AND H. GUTBIER. *Z. Phys.*, **133**, *No.* 4, 451–4 (1952) *In German.*

Gives results of expts. with a mass spectrograph on the decomposition products formed during repeated discharges in Geiger counters containing CH_2Cl_2 and CH_2Br_2. Mass spectra are given after counts varying from 0 to 2×10^8 in number. The formation of HCl or HBr during the counting appears to be the most important factor in limiting the counting life to $\sim10^8$ counts. Argon was used as the main component of the gas filling. J. D. CRAGGS

537.542 : 548.733

A counter tube arrangement for X-ray measurements. *See Abstr.* 2073

537.542

1697. Hydrogen-methylal fillings for Geiger–Müller counters with external cathodes. D. BLANC. Letter in *J. Phys. Radium*, **13**, 588–9 (*Nov.*, 1952) *In French.*

A brief note on counter filling details. An advantage of the external cathode arrangement (Maze's method) is that, it is claimed, adsorption tends to be decreased, compared with the ordinary system of internal cathode. J. D. CRAGGS

537.542

1698. Scintillation detectors for α-particles. A. MALVICINI. Note in *Nuovo Cimento*, **9**, 535–8 (*June*, 1952) *In Italian.*

Describes scintillation counter for the detection of radioactive contaminations of α-particle emitters. Its main features are: high sensitivity, simple building and easy use. This counter is insensitive to X- and γ-rays; under conditions of good α-particle detection, its background is less than 10 pulses per hour. A.

537.542

1699. The detection of particles by scintillations. I. Photomultipliers. D. BLANC, J. F. DETŒUF AND P. MAIGNAN. *J. Phys. Radium*, **13**, 567–72 (*Nov.*, 1952) *In French.*

A review of photomultiplier characteristics, their measurement and practical defects as shown by typical commercial tubes. Discussion of photosensitive G.M. tubes used with scintillators is given. G. F. J. GARLICK

537.542

1700. The detection of particles by scintillations. II. Scintillators. J. F. DETŒUF, D. BLANC AND P. MAIGNAN. *J. Phys. Radium*, **13**, 573–8 (*Nov.*, 1952) *In French.*

A review of solid and liquid scintillators used in practice and their application to the measurement of various nuclear radiations. G. F. J. GARLICK

537.542

1701. The Rosenblum spark counter. G. G. EICHHOLZ. *Nucleonics*, **10**, 46–9 (*Oct.*, 1952).

Spark counters of the Rosenblum wire type are described. Curved cathode plates, convex towards the anode wire, were employed to localize the field and reduce the operating voltage to 3000–4000 V. The behaviour of these counters with α-particles has been investigated in the end-on position, i.e. with the α-particles directed along the line from the anode to the cathode, and in the broadside-on position at right angles to this, the latter giving rather better characteristics. Two multiple counters consisting of an array of the curved cathode counters, one with these in the end-on position, and the other with them in the broadside-on position, are described. These counters combine high sensitivity, low background, insensitivity to β-rays and γ-rays, fast response, robustness, ease of construction and elimination of pulse amplifiers. L. R. SHEPHERD

537.542

1702. Devices for calibration of slow-counting-rate meters. R. L. Ives. *Nucleonics*, **10**, 64–6 (*Oct.*, 1952).

The devices were required to give pulses up to 70 V maximum height, simulating a G.M. counter output. A scalar operating on a 60 c/s supply and a rotating perforated disk photoelectric pulse generator, were investigated but were not suitable for the required purpose. A small portable instrument, giving 30 or 60 pulses per minute, was eventually designed. The pulse is produced by discharging a condenser through a Ne tube and the primary of an output transformer. A Ge 1N34 rectifier in the primary prevents reversal of polarity. The switching is controlled by a 7½ r.p.m. synchronous motor and a 4 or 8-toothed cam to give the necessary pulse repetition rate. L. R. SHEPHERD

537.542 : 621.318.572

1703. A fast coincidence circuit for experiments with high energy particles. J. M. Dickson, D. C. Salter, O. Gunnill, P. Dolley and J. M. Cassels. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. G/R* 1039, 3 *pp.* (*Oct.* 14, 1952).

A simple fast double-coincidence circuit is described in which the pulses are standardized and mixed before amplification. It has been tested both with artificial pulses and with pulses produced by 147 MeV protons from the Harwell cyclotron. Resolving times of the order of 5×10^{-9} sec were comfortably achieved. It is suggested that the circuit could be adapted to record triple coincidences. A.

537.542 : 621.318.572 : 621.396.645.018.75

1704. A special pulse amplifier giving time selection. A. Alberigi, F. Lepri and G. Stoppini. Note in *Nuovo Cimento*, **9**, 365–8 (*April*, 1952) *In Italian.*

Selects the last pulse in a temporal succession of an unknown number of pulses, distributed in an arbitrary way within a fixed time interval. A.

537.543 : 621.3.015.1 : 621.385.3

1705. Potential distribution for space-charge limited current between a plane accelerating grid and parallel anode. E. G. Ramberg and L. Malter. *J. appl. Phys.*, **23**, 1333–5 (*Dec.*, 1952).

Expressions are derived for the potential distribution between a plane accelerating grid and parallel anode under conditions of space-charge limitation, taking account of the Maxwellian velocity distribution of the electrons. The distribution is determined by Langmuir's diode functions in combination with a function depending on the current transmission of the grid-anode space, which is represented graphically. A.

IONIZATION . THERMIONICS 537.56/.58

537.56

1706. Diffusion, de-excitation, and ionization cross sections for metastable atoms. I. M. A. Biondi. *Phys. Rev.*, **88**, 660–5 (*Nov.* 1, 1952).

The lifetimes of metastable atoms in gases are determined from studies of the ionization which they produce in the afterglow following a pulsed discharge. Two distinct types of ionizing reactions are studied, the first in which the collision of a pair of metastable atoms results in ionization of one of them and de-excitation of the other, the second in which a metastable atom of one type loses its excitation energy in ionizing a normal atom of another type. From studies of this ionization as a function of various experimental parameters such as gas pressure, values of the diffusion, de-excitation and ionization cross-sections of metastable He and Ne atoms are obtained. The various measured cross-sections agree reasonably well with values obtained from modern optical absorption studies. A.

537.561

1707. Molecular images with the projection microscope. The ionization potential of zinc phthalocyanine. R. Gomer and D. A. Speer. *J. chem. Phys.*, **21**, 73–80 (*Jan.*, 1953).

The current emerging from single molecules of zinc phthalocyanine in field emission has been measured as a function of voltage. The data permit estimation of the ionization potential at *c.* 7 V. Comparison of the experiments with a simple theory based on the emission of electrons from the molecule itself supports this view of image formation. It is shown that the images found are not diffraction patterns, but the result of electron optical effects. Emission measurements on molecules adsorbed on clean tungsten substrates show that irregularities of 5–10 Å exist on the best and cleanest of these surfaces. A.

537.564

1708. The formation of negative ions of sulfur hexafluoride. A. J. Ahearn and N. B. Hannay. *J. chem. Phys.*, **21**, 119–24 (*Jan.*, 1953).

Negative ion production in SF_6 has been studied in a mass spectrometer; SF_6^-, SF_5^-, F_2^- and F^- were identified. The SF_6^- and SF_5^- are produced in very large quantities by a resonance capture process at an electron energy of about 2 eV, and are formed in approximately equal amounts. At higher electron energies, the same capture occurs by a secondary process, in which low energy electrons released by other excitation and ionization processes suffer the resonance capture. Partial dissociation after electron capture accounts for the appearance of F^- and F_2^- ions below 16 eV. Above this energy, other processes will also produce these ions. Possible explanations of the primary resonance capture mechanism are discussed. A.

537.564 : 621.3.015.532

1709. Ions formed by corona discharge. H. Norinder and R. Siksna. *I.V.A.* [*Stockholm*] **23**, *No.* 6, 234–45 (1952).

An experimental arrangement is described, incorporating several types of ion counter, to determine the ions produced by a 0·25 mm wire when subjected to a voltage up to ~30 kV. Several curves are given showing the variation with time of voltage application of the number of ions measured with the different types of equipment available. From these curves others are derived showing the corresponding movement of various groups of ions. The factors investigated include: polarity; rate of rise of applied

oltage; effect of disconnecting voltage. The relative importance of small and large ions is examined and the formation process of ions by corona is discussed.

R. H. GOLDE

537.568

1710. Electron affinity spectrum of neutral H_2. W. LOCHTE-HOLTGREVEN AND W. NISSEN. *Z. Phys.*, **133**, *No.* 1–2, 124–33 (1952) *In German.*

Under fixed conditions of electron pressure and temperature, this spectrum is, as expected, near the recombination continuum. These conditions are obtained experimentally for the two different types of emission. Experiments on the continuum are in agreement with theory.

F. LLEWELLYN JONES

537.583 : 621.385.032.216

1711. Excess thermal noise due to current flow through (Ba Sr) oxide coating. K. AMAKASU. *J. appl. Phys.*, **23**, 1330–2 (*Dec.*, 1952).

A study has been made to clarify the nature of the noise and to determine how much this noise affects the flicker noise. The results show that (1) the excess noise generated by the flow of current is proportional to the square of the current flowing through the coating layers, (2) the frequency spectrum of the noise is inversely proportional to the frequency, (3) the noise is greatly affected by the activation of cathode, a slight decrease in activation causing a sudden increase of noise, (4) the portion of the cathode flicker noise due to this excess noise may be neglected when the activation of the cathode is good, but when the activation is poor, it becomes considerably larger. The characteristic of (3) may be considered to give a clue to the electron conductivity mechanism in the oxide cathode.

A.

COSMIC RAYS 537.591

537.591.1

1712. On the vertical and inclined positive excess of μ-mesons. E. BERETTA, I. FILOSOFO AND B. SOMMACAL. *Nuovo Cimento*, **9**, 317–23 (*April*, 1952) *In Italian.*

Differential measurements have been made at sea level on the positive excess of μ-mesons in the energy interval between $0{\cdot}7$ and $1{\cdot}5 \times 10^9$ eV. The results are: $\delta = 0{\cdot}21 \pm 0{\cdot}025$ in the vertical direction, $\delta_{east} = 0 \pm 0{\cdot}023$ in the 45° east, and $\delta_{west} = 0{\cdot}41 \pm 0{\cdot}025$ in the 45° west direction. The last values are explained by the influence of the earth's magnetic field on meson trajectories. By considering the same influence a value $\delta = 0{\cdot}21 \pm 0{\cdot}018$ of the excess at generation is deduced from the measurements in the inclined directions.

A.

537.591.1

1713. On the "N" component of high-energy cosmic rays. P. BUDINI AND G. LANZA. *Nuovo Cimento*, **9**, 381–90 (*May*, 1952) *In Italian.*

A theory of the nucleonic cascade holding for energies larger than some 10^9 eV is outlined; bremsstrahlung-like cross-sections depending on the fractional energy (primary energy/secondary energy) are used, and recoil nucleons, fluctuations as well as deviations of the primary spectrum from a pure power law (Winckler, 1950), are taken into account. It is found that the behaviour of the nucleonic component in the atmosphere, in particular the variation with energy of the absorption thickness (consequence of Winckler's spectrum) is well fitted with data experimentally derived; this circumstance justifies the hypothesis of the bremsstrahlung-like cross-section in the considered energy range. For energies larger than $\sim 10^{10}$ eV cross-sections are expected to deviate from the bremsstrahlung law for the following two reasons: (*a*) as the energy increases new particles, like pions, are contributing to the nucleonic cascade; (*b*) the multiplicity of the generated particles increases with energy. If one considers these deviations as rather slow-varying functions of the energy, it is possible to apply the usual mathematical procedure and it may be argued, by the aid of considerations rather largely independent of the particular form of the cross-sections, that the deviation (*a*) may be responsible for a partial increase of the absorption path, whereas the hypothesis (*b*), which comes into consideration for energies larger than those implied by the hypothesis (*a*), yields a diminution of the absorption path with increasing energy up to an asymptotic value practically equal to the geometrical path, for those processes in which a particle entirely loses its individuality in a single collision (catastrophic processes) and sensibly larger in processes characterized by an anelasticity constant smaller than 1.

A.

537.591.1

1714. Measurement of positive excess at low energy by means of a nuclear plate sandwich in a magnetic field. M. MERLIN, B. VITALE AND Y. GOLDSCHMIDT-CLERMONT. *Nuovo Cimento*, **9**, 421–8 (*May*, 1952) *In Italian.*

Ilford G5 nuclear plates 400 μ thick have been exposed in sandwich [see Abstr. 7338 (1950)] with a space of $3{\cdot}2$ mm of air between them in a magnetic field of 30 000 oersted at sea level. The positive excess of μ-mesons at the end of their range has been measured and the value $\eta = 0 \pm 0{\cdot}27$ obtained for it. The sensitivity of the method for the determination of either the mass or the sign of the charge is discussed in relation to the geometrical conditions and possible distortions of the emulsions.

A.

537.591.1

1715. μ-Meson spectrum at sea level. D. BRINI, O. RIMONDI AND I. FILOSOFO. *Nuovo Cimento*, **9**, 505–10 (*June*, 1952) *In Italian.*

The range differential spectrum of μ-mesons has been determined at sea level between 1000 and 3500 MeV/c in order to gain evidence of an anomaly supposed to be present [Abstr. 1905 (1951)]. From the results obtained the authors conclude that in this energy interval there are no irregularities greater than a few per cent.

A.

537.591.1

1716. A note on the measurement of lifetime of unstable particles. J. G. WILSON AND C. C. BUTLER. Letter in *Phil. Mag.*, **43**, 993–5 (*Sept.*, 1952).

The problem of determining the lifetimes of unstable particles ($V\pm$ τ, $V^0_{1,2}$) from cloud chamber

photographs is discussed and suggestions are made as to the way in which observations should be reported so that data from independent groups of workers may be readily combined. H. ELLIOT

537.591.1

1717. Cloud chamber photographs of the cosmic radiation. G. D. ROCHESTER AND J. G. WILSON. *London, Pergamon Press* (1952) 128 + viii *pp.*

Review in *Brit. J. appl. Phys.*, **3**, 397 (*Dec.*, 1952).

537.591.1

1718. Apparent absence of low-energy primary cosmic radiation. E. G. DYMOND. Letter in *Nature* [*London*] **170**, 1078 (*Dec.* 20, 1952).

From recent measurements of Pomerantz and McClure [Abstr. 5876 (1952)], the knee in the curve of the latitude effect at the top of the atmosphere is calculated to occur at 56°, corresponding to a cut-off in the primary spectrum at energy 500 to 600 MeV.

E. P. GEORGE

537.591.1

1719. Production of slow mesons in the glass of photographic plates. ZH. S. TAKIBAEV AND B. K. KAZIEVA. Letter in *Zh. eksper. teor. Fiz.*, **22**, *No.* 6, 783–4 (1952) *In Russian.*

Mesons stopping in the emulsion were classified into those entering from the air and those entering from the glass, and the relative numbers recorded with and without a 5 mm Pb absorber at 4700 m elevation. E. P. GEORGE

537.591.15

1720. On the photon component of extensive air showers. P. BASSI, A. M. BIANCHI AND C. MANDUCHI. *Nuovo Cimento*, **4**, 358–64 (*April*, 1952) *In Italian.*

The photons of extensive showers are studied at sea level and at 2000 m with the anticoincidence method. The ratio between photons and electrons appears practically independent of the height and increases with the shower-density. The photonic component present under heavy layers of lead is made evident. A.

537.591.15

1721. On the methods of solution of electrophoton cascade equations. F. MONTICELLI. *Nuovo Cimento*, **9**, 477–86 (*June*, 1952) *In Italian.*

By using Laplace transformations, the diffusion equations of the shower theory are reduced to a Volterra integral equation, a solution of which is obtained by using the method of successive approximations. It is shown that this solution corresponds to Scott's one. Further it is shown that the same equation leads to the solution of Bhabha and Chakrabarty. A.

537.591.15

1722. The third and fourth maxima of the shower curve. H. THURN. Note in *Z. Naturforsch.*, **7a**, 497–9 (*July*, 1952) *In German.*

The Rossi transition curve is reported to contain 4 maxima, attention being concentrated on the 4th, the position of which was found to depend strongly on atmospheric pressure. E. P. GEORGE

537.591.15

1723. The transition effect for cosmic-ray bursts at small thicknesses of lead. J. R. PRESCOTT. *Proc. Phys. Soc.* [*London*] *A*, **65**, 925–9 (*Nov.*, 1952).

The transition curve for cosmic-ray bursts under Pb at sea level is analysed to find the contributions from stars, extensive showers, electromagnetic interactions of μ-mesons, and single high-energy electrons and photons. When this is done, a substantial fraction of the bursts under Pb thicknesses less than about 2·5 cm remains unaccounted for. It is suggested that they are produced by "narrow air showers" consisting predominantly of photons of about $2{\cdot}5\times10^{8}$ eV and having a sideways spread of less than 0·3 m. A.

537.591.15

1724. On the origin of cosmic ray bursts. G. ROCHET AND J. DAUDIN. *C.R. Acad. Sci.* [*Paris*] **235**, 1121–3 (*Nov.* 10, 1952) *In French.*

The barometer coefficient and absolute rate of bursts detected by means of counters surrounded by lead have been measured at 550 m altitude and the results are compared with the corresponding values for 2860 m and for sea level. The contribution of the nucleon component to burst production is estimated to be 92% at 2860 m, 67% at 550 m and 55% at sea level. There is some slight evidence for a temperature effect on the burst frequency. H. ELLIOT

537.591.15

1725. Lateral scattering moments in showers. L. W. NORDHEIM. *Z. Phys.*, **133**, *No.* 1–2, 94–100 (1952) *In German.*

A recursion formula is derived for the moments of all orders of the angular and lateral scattering in showers, from which it is in principle possible to calculate the moments with the help of the function describing the longitudinal development of the shower. E. P. GEORGE

537.591.3

1726. On the energy range relation for fast muons in rock. M. MANDÒ AND L. RONCHI, JR. *Nuovo Cimento*, **9**, 517–29 (*June*, 1952).

A discussion is given of the best estimate of various types of energy loss; the energy-range relation for muons in rock and water is then evaluated. Apart from the uncertain amount of "nuclear" losses this relation should be quantitatively correct to about 1%. Finally two different curves are given, corresponding to zero "nuclear" losses and $1{\cdot}0\times10^{-6}$ g^{-1} cm^2 fractional "nuclear" energy losses respectively; within them, linear interpolation (for any amount of "nuclear" losses) is allowed. A.

537.591.5

1727. Cosmic ray asymmetry studies at Hobart, Tasmania. D. W. P. BURBURY AND A. C. MCLAREN. Note in *Austral. J. sci. Res. A*, **5**, 782–3 (*Dec.*, 1952).

The east-west asymmetry at zenith angle 45° and the north-south asymmetry at zenith angle 30° have been measured. Values obtained were $0{\cdot}0177 \pm 0{\cdot}0011$ and $0{\cdot}0056 \pm 0{\cdot}0013$ respectively. No significant correlation between the asymmetry and barometric pressure, heights of given pressure levels

or mean temperature above these levels could be detected. The barometer coefficients for the mean intensity at 30° and 45° zenith angle were found to be $-1{\cdot}90 \pm 0{\cdot}08$ and $3{\cdot}56 \pm 0{\cdot}05\%$ per cm Hg respectively. H. ELLIOT

537.591.5

1728. Diurnal variations in the intensity of cosmic rays underground. N. SHERMAN. *Phys. Rev.*, **89**, 25–6 (*Jan.* 1, 1953).

The number of coincidences between two trays of Geiger counters located at a depth of $8{\cdot}46 \times 10^4$ g cm^{-2} underground was recorded each hour, and these data were analysed for variation of cosmic-ray intensity with solar and sidereal times. (A total of $7{\cdot}4 \times 10^5$ μ-mesons was observed whose average energy is estimated to be 2×10^{11} eV.) In each case the standard deviation of the observed coincidence rates from the mean rate is not larger than the standard deviation expected from a normal distribution. The first harmonic amplitudes of the solar and sidereal variations indicate that the data are equally consistent with an assumed daily sinusoidal variation in the coincidence rates of $\sim 0{\cdot}5\%$ and with the absence of such variation. The difficulties involved in deducing directional properties of the primary cosmic radiation from harmonic analysis of variations in secondary radiation underground are discussed. A.

537.591.5 : 550.37

1729. Effect of equatorial ring current on cosmic-ray intensity. S. B. TREIMAN. *Phys. Rev.*, **89**, 130–3 (*Jan.* 1, 1953).

The equatorial ring current postulated by Chapman and Ferraro to explain the main phase of terrestrial magnetic storms is analysed with respect to its effect on the intensity of the cosmic radiation. For mathematical convenience, the ring current is replaced by a current sheet located on the surface of a sphere concentric with the earth, in accordance with a suggestion due to Chapman. A simple expression is then obtained relating the variations in magnetic field at the equator with the corresponding variations to be expected in the intensity of cosmic radiation measured by an arbitrary detector located at any latitude and atmospheric depth. A.

537.591.8

1730. Multiple production of mesons in penetrating showers. G. BERTOLINO, M. CINI, P. COLOMBINO AND G. WATAGHIN. *Nuovo Cimento*, **9**, 407–12 (*May*, 1952) *In Italian.*

Fourfold, fivefold and sixfold coincidences were registered simultaneously in two identical arrangements with paraffin on one and graphite on the other, or without these materials. The graphite layer (85·3 kg) had a thickness of 12 g/cm^2 whereas the paraffin layer contained 12 g/cm^2 of C + 2 g/cm^2 of H. The coincidence set had a resolving time of 0·9 μsec for all orders of coincidences. The influence of the barometric pressure on the frequency of penetrating showers (PS) was carefully studied and a barometer effect of $(21 \pm 3)\%$ per cm of Hg found for the kind of PS selected by the above arrangement. From the comparison of the frequencies without materials: $(f_6/f_5) = 0{\cdot}5 \pm 0{\cdot}05$ and the frequencies: $[(f_6)_P - (f_6)_G]/[(f_5)_P - (f_5)_G] = 0{\cdot}8 \pm 0{\cdot}3$ it follows that the average multiplicity of the observed PS is: $\bar{n} \gtrsim 10$ (per 0·4 m^2) (also for those created in the nucleon–proton collision). A discussion of various possible cases of simultaneous arrival of two or more nucleons on the producing layers and of a double collision in the paraffin layer (a first collision with a proton and a second collision with a carbon nucleus) shows that all these cases cannot contribute more than a few percent to the observed effect. One concludes that the observed excess of production of PS in paraffin compared with graphite must be interpreted as an evidence of multiple production of mesons in the collision of incident nucleons with the protons in H. PS incident on an area of ~ 5 m^2 and containing more than 200 mesons are observed. A.

537.591.8

1731. Interpretation of cosmic-ray measurements far underground. P. H. BARRETT, L. M. BOLLINGER, G. COCCONI, Y. EISENBERG AND K. GREISEN. *Rev. mod. Phys.*, **24**, 133–78 (*July*, 1952).

The absorption in 50 cm Pb at a depth of 1600 m water equiv. was found to be $1{\cdot}25 \pm 0{\cdot}17\%$, the particle flux $3{\cdot}3 \times 10^{-7}$ cm^{-2} sec^{-1} sterad^{-1}, with a $\cos^3$ dependence on θ. The variation of intensity with depth, x, is estimated to be of the form $x^{-3{\cdot}5}$. The difference in exponents of the angular and depth functions is discussed in terms of the decay of π- and/or heavier meson parents of the observed μ-mesons. As temperatures near the 100 mb layer behave differently from those in the rest of the atmosphere, a weighted mean temp. was defined (T_{eff}). The temp. coeff. using T_{eff} was found to be $0{\cdot}79 \pm 0{\cdot}20\%$ degree^{-1}. 0·9% of the underground particles were recorded in coincidence with one counter on the surface, and a further 0·6% with 2 or more surface counters, consistent with the assumption that all underground particles are contained in air showers of >400 electrons. Observations were made of coincidences between several sets of Pb shielded counter-trays underground, out to a maximum tray separation of 23 m. The decoherence curve is found to be due to the superposition of 2 components—at small separations the events are due to local penetrating showers, produced by μ-mesons; at large separations they are due to penetrating particles in air showers. The latter events have a differential number distribution proportional to $N^{-\delta}$ with $\delta = 3{\cdot}4 \pm 0{\cdot}1$. Provided the photonuclear cross-section is 10^{-27} cm^2 nucleon^{-1} at 5×10^9 eV, the observed nuclear interactions of fast μ-mesons may be explained in terms of electromagnetic interactions, the observed cross-section for μ-mesons being given as $\sigma_\mu \geqslant (4 \pm 2) \times 10^{-29}$ cm^2 nucleon^{-1}. E. P. GEORGE

537.591.8

1732. Study of isolated tracks produced in nuclear emulsions by cosmic radiation. H. MOUCHARAFYEH. *Ann. Phys.* [*Paris*] 7, 564–603 (*July–Aug.*, 1952) *In French.*

A detailed analysis has been made of the directional intensities, energy distributions and nature of the particles responsible for the isolated tracks of ranges greater than 60 microns in nuclear emulsions. The

great majority of single tracks are protons. 170 nuclear disintegration "stars" in the emulsion have been similarly analysed with the conclusion that the single tracks are not due to "stars" formed in the neighbourhood of the plates. A. C. COATES

537.591.8

1733. The mean energy of three-track nuclear disintegrations produced by cosmic-ray particles. D. A. TIDMAN AND P. E. HODGSON. Letter in *Phil. Mag.*, **43**, 992–3 (*Sept.*, 1952).

Three-track stars in G5 emulsions exposed without absorber have been examined with high scanning efficiency and the mean energy is found to be 196 ± 18 MeV. This is significantly larger than the value 147 MeV obtained by extrapolating the empirical relation of Brown *et al.* [Abstr. 6317 (1952)] which gives the total energy in MeV as $4N^2 + 37N$ for stars with the number of tracks (N) between 4 and 18. H. ELLIOT

537.591.8

1734. A statistical study of the distribution of stars in nuclear emulsions. F. B. BROWN, JR AND A. V. MASKET. Letter in *Phys. Rev.*, **88**, 1204–5 (*Dec.* 1, 1952).

The observed distribution of the distance of each of 1723 nuclear disintegration "stars" from its nearest neighbour shows that the number of close pairs is greater than that expected on a random basis. The distribution of small "stars" of 3, 4 and 5 "prongs" is random, but the distribution of larger "stars" is non-random. A. C. COATES

537.591.8

1735. Angular distribution functions for high energy cosmic-ray particles. H. S. GREEN, H. MESSEL AND B. A. CHARTRES. *Phys. Rev.*, **88**, 1277–83 (*Dec.* 15, 1952).

The main purpose is to provide theoretical data which should enable one (*a*) to distinguish between two different types of differential cross-sections for nuclear collisions at high energies, equally compatible with present experimental indications, and (*b*) to differentiate between certain models of meson production. The exact angular distribution function is determined on the basis of one type of differential cross-section, for both mesons and nucleons, in high energy nucleon–nucleus collisions, and in any type of medium. For both types of cross-section, formulae are derived for the general moment of the angular distribution. Numerical results for the mean square angle of scattering of mesons and nucleons in collisions between a nucleon and a nucleus are presented graphically for both light and heavy nuclei. A.

537.591.8

1736. Coulomb and nuclear interactions of cosmic-ray mesons and protons in lead. W. L. WHITTEMORE AND R. P. SHUTT. *Phys. Rev.*, **88**, 1312–21 (*Dec.* 15, 1952).

A cloud-chamber experiment shows that positive and negative particles at sea level in the momentum range 0·3–3·1 BeV/c scatter in 5 cm of Pb in the same manner. The experimental scattering distributions have a large-angle "tail" which agrees rather well with the theoretical distributions of Molière and of Snyder and Scott who assumed that the nucleus scatters like a point charge. These distributions should not be valid here because the charge distribution within the nucleus must be considered in detail for such energetic mesons. The recent calculation of Olbert specifically neglecting the scattering of particles which penetrate the nucleus predicts a much smaller probability for large-angle scattering than observed. A rough extrapolation of the calculations of Amaldi *et al.* to the case of Pb shows that it is possible to explain perhaps 10% of the observed large-angle scattering as due to inelastic electric scattering within the nucleus, if the radius of the electric charge on a proton is taken to be 2×10^{-14} cm. Negative particles observed at 3·4 km altitude scatter in Pb much the same as the sea-level particles. The scattering of positive particles observed at 3·4 km altitude indicates that protons in the momentum range 1–4·8 BeV/c suffer a small amount of nuclear scattering in Pb corresponding to $(0{\cdot}13 \pm 0{\cdot}07)\sigma_g$, where σ_g is the geometrical cross-section. All nuclear interactions combined give a total interaction cross-section for Pb of $(0{\cdot}38 \pm 0{\cdot}09)\sigma_g$. These surprisingly small cross-sections are compared with other data from the literature. A.

537.591.8 : 523.51

Meteorites and cosmic rays. *See Abstr.* 1340

MAGNETISM 538

538.081.1 : 537.081.1 : 621.3.081

1737. Extension and dissemination of the electrical and magnetic units by the National Bureau of Standards. F. B. SILSBEE. *Circ. Nat. Bur. Stand., No.* 531, 33 *pp.* (1952).

Starting with the ohm and the volt as maintained by groups of standard resistors and cells, this paper describes the experimental processes by which the other electric and magnetic units, e.g. farad, henry, ampere, watt, joule, gauss and oersted are derived. It also describes the series of steps by which the scales of measurement of resistance, direct and alternating current, and voltage are derived experimentally. Brief mention is made of the procedures for the dissemination of these standards of measurement throughout the world by the calibration of standard electrical measuring apparatus. A bibliography of 255 items lists papers describing the measurement procedures in greater detail. A.

538.114

1738. Spin degeneracy and the theory of collective electron ferromagnetism. A. B. LIDIARD. *Proc. Phys. Soc.* [*London*] *A*, **65**, 885–93 (*Nov.*, 1952).

The theory of ferromagnetism is often developed on the assumption that the exchange energy responsible for the magnetization is adequately represented as a sum of exchange integrals between pairs of electrons with mutually parallel spins. This is equivalent to using for the total wave function a determinant built up of one-electron functions. For the magnetized states of interest in ferromagnetism a single determinant wave function must be regarded as inadequate

on account of the so-called spin or exchange degeneracy, which requires us to use instead appropriate linear combinations of the degenerate determinants. In the present paper a model is presented for which the results of neglecting or taking account of this spin degeneracy are identical. The model can be handled exactly and leads to equations for the free energy, magnetization, etc., which are a generalization of Stoner's theory of ferromagnetism to a system with two energy bands; these could be the overlapping 3*d* and 4*s* bands in the iron transition series. The calculations are not necessarily restricted to ferromagnetic metals and would apply equally well to those that are paramagnetic. A.

538.114

1739. Spin-lattice relaxation in ferromagnets. E. Abrahams and C. Kittel. Letter in *Phys. Rev.*, **88**, 1200 (*Dec.* 1, 1952).

Describes a calculation of the spin-lattice relaxation time τ based on a macroscopic spin-lattice interaction large enough to account for the observed magnetoelastic energy. A curve is given relating τ to the absolute temperature in nickel for an applied field of 5300 oersted. The calculated τ values are found to be very sensitive to the values of the characteristic parameters, such as the Bloch wall coefficient. See also abstract following. E. P. WOHLFARTH

538.114

1740. The concept of spin-lattice relaxation in ferromagnetic materials. P. W. Anderson. Letter in *Phys. Rev.*, **88**, 1214 (*Dec.* 1, 1952).

Gives a theoretical discussion showing that in calculations of the high frequency properties of ferromagnetics, spin-lattice and spin-spin relaxation must be considered differently than in calculations for paramagnetics. An indication is also given of the conditions under which spin-lattice relaxation could be observed in experiments on ferromagnetics. See also preceding abstract. E. P. WOHLFARTH

538.114

1741. Quantum theory of a new origin of ferromagnetism (preliminary communication). G. Heber. *Ann. Phys.* [*Leipzig*] **11**, *No.* 1, 48–50 (1952) *In German.*

A continuation of previous work [*Wiss. Z. Univ. Jena, Math.-nat.-Reihe*, **1**, 79, 95 (1952)]. The influence of indirect *s–d* coupling (Zener) on the shape of the magnetization/temperature curve at low temperatures is discussed. The *d* as well as the *s* electrons are described by Bloch-type wave functions. A generalized spin wave treatment is carried out and the $T^{3/2}$ law is derived only as a special case. It is concluded that *s–d* coupling effects are of secondary importance compared with those arising from direct *d–d* coupling. E. P. WOHLFARTH

538.114

1742. The structure of the ferromagnetic state in α-iron and some iron alloys. G. Heber. *Ann. Phys.* [*Leipzig*] **11**, *No.* 2–3, 155–60 (1952) *In German.*

Gives a critical discussion of Zener's theory [Abstr. 2832 (1952)]. Experiments to test this theory are suggested. The relation to Néel's theory of ferrimagnetism is discussed, and this theory is extended to the case of a superlattice of ions with different magnetic moments on the two sublattices. See also preceding abstract. E. P. WOHLFARTH

538.114

1743. The effective mass of a Bloch wall. R. Becker. *Z. Phys.*, **133**, *No.* 1–2, 134–9 (1952) *In German.*

A theoretical discussion. It is shown that in the absence of frictional forces the acceleration of a Bloch wall in an external field, rather than the velocity, is proportional to the field strength. A new derivation of the formula for the effective mass of the wall is given. E. P. WOHLFARTH

538.114 : 538.23

1744. Theoretical discussion of the influence on the coercive force of spheroidal inclusions of size small compared with the width of the Bloch wall. E. Schwabe. *Ann. Phys.* [*Leipzig*] **11**, *No.* 2–3, 99–112 (1952) *In German.*

Previous theoretical discussions (Kersten, Néel) are extended to include the case of nonspherical inclusions. It is shown that the calculated H_c values are sensitive to even quite small deviations of the dimensional ratio from 1. Full calculations are carried out for the case of the movement of 180° walls past spheroids whose polar axes are parallel to the directions of easy magnetization. A range of values of the dimensional ratio is considered. The influence of the spatial statistical distribution of the inclusions and of their possible ferromagnetism is discussed. E. P. WOHLFARTH

538.13 : 538.082.743

1745. The flux distribution of a magnetic dipole with reference to small Barkhausen discontinuities. E. W. Elcock. *Proc. Leeds Phil. Lit. Soc.*, **6**, *Pt* 1, 1–11 (1952).

Derives an expression for the flux distribution of a magnetic dipole on the axis of an infinite cylindrical specimen. The variation with the permeability and radius of the specimen is investigated. The signal strength in a coaxially-wound detecting coil due to the reversal of the dipole is examined. Application to methods of detecting small Barkhausen reversals in ferromagnetic specimens is discussed. E. P. WOHLFARTH

538.221

1746. Antiferromagnetism and ferrimagnetism. L. Néel. *Proc. Phys. Soc.* [*London*] *A*, **65**, 869–85 (*Nov.*, 1952).

The present position is reviewed, and some phenomena concerning the magnetic behaviour of certain ferrites and of pyrrhotite are described and explained. A.

538.221

1747. The *g* factor of ferrite. T. Okamura, Y. Torizuka and Y. Kojima. Letter in *Phys. Rev.*, **88**, 1425 (*Dec.* 15, 1952).

Describes measurements of the apparent *g* factor of polycrystalline Ni and Mn ferrite specimens at frequencies between 9450 and 47 000 Mc/s. The observed frequency dependence is explained by invoking the presence of an anisotropic internal field, having the values 507 and 278 oersted for Ni and Mn ferrite respectively. The actual *g* values deduced are close to the theoretical value 2. E. P. WOHLFARTH

538.221

1748. Antiferromagnetic resonance above the Curie temperature. R. K. WANGSNESS. *Phys. Rev.*, **89**, 142–4 (*Jan.* 1, 1953).

The role of short-range order in effecting the disappearance of absorption as the Curie temperature is approached is discussed. The prediction of a simple theory of the effect agrees very well with experimental results from MnO. Consideration is also given to the relation of resonance experiments and studies made by neutron diffraction. A.

538.222

1749. On the phenomenon of "wiggles" or "beats" in nuclear magnetic resonance signals. J. N. BHAR AND B. N. BHAR. *Sci. and Culture*, **18**, 86–8 (*Aug.*, 1952).

According to the theory of Jacobsohn and Wangsness [Abstr. 2530 (1948)], the number of beats depends, among other things, on the speed, $(\partial H_0/\partial t)_{res}$, with which the modulated field passes through its resonance value. This phenomenon was qualitatively demonstrated without changing amplitude and frequency of H_0. A rough measurement of the transverse relaxation time for $NiSO_4$ gave the result $1{\cdot}2\times10^{-4}$ sec. L. PINCHERLE

538.222

1750. Hyperfine structure in [the paramagnetic resonance spectrum of] neodymium ethyl sulphate. B. BLEANEY, H. E. D. SCOVIL AND R. S. TRENAM. Letter in *Phil. Mag.*, **43**, 495–7 (*Sept.*, 1952).

An extension of previous measurements [Abstr. 1981 (1951)]. To obtain further information about the quadrupole moments, the h.f. transitions were plotted into zero field using wavelengths of 7–20 cm. Inconsistencies were found, hitherto unexplained. L. PINCHERLE

538.222

1751. Paramagnetic resonance in praseodymium ethyl sulphate. B. BLEANEY AND H. E. D. SCOVIL. Letter in *Phil. Mag.*, **43**, 999–1000 (*Sept.*, 1952).

The spectrum was observed at 20°K. The value 5/2 was confirmed for the spin of the only isotope, 141. $g_{||}$ was found to be $1{\cdot}69 \pm 0{\cdot}01$, while susceptibility measurements give 1·56. Reasons for the discrepancy are discussed. L. PINCHERLE

538.222

1752. Paramagnetic resonance absorption in salts of V and Mn. C. A. HUTCHISON, JR AND L. S. SINGER. *Phys. Rev.*, **89**, 256–62 (*Jan.* 1, 1953).

Paramagnetic resonance absorptions in tetravalent, trivalent and divalent salts of V and in a divalent salt of Mn have been investigated at room temperature and at a frequency of $9{\cdot}2\times10^{9}$ sec^{-1}. A detailed study has been made of the absorption in single crystals of the Tutton salt of V^{+2} as a function of orientation. The results have been interpreted on the basis of crystalline electrostatic fields. A.

538.222 : 536.48

1753. Interpretation of the de Haas–van Alphen effect. L. ONSAGER. Letter in *Phil. Mag.*, **43**, 1006–8 (*Sept.*, 1952).

It is shown that in the de Haas–van Alphen effect the equal intervals of reciprocal magnetic field at which the oscillations of susceptibility occur are given by $(hc/e)A$, where A is any extremal area of intersection in momentum space between the Fermi surface and planes normal to the field. D. SHOENBERG

538.222 : 548.736.5 : 536.21

Physical properties of chromium alums at low temperatures. *See Abstr.* 1573

538.224 : 539.133

1754. The diamagnetic anisotropy of four-ring condensed aromatic hydrocarbons. R. PAUNCZ AND F. BERENCZ. *Acta phys. Hungar.*, **2**, *No.* 3, 183–93 (1952).

The anisotropy was investigated on the basis of F. London's quantum mechanical method. It has been attempted to establish in the case of an identical number of rings, how the diamagnetic anisotropy depends on the shape of the molecule. In general the results of the theoretical calculations are in good agreement with the experimental values. The deviation does not exceed 7%. A.

538.23

1755. Internal friction of ferromagnetic substance due to rotation of spontaneous magnetization. N. KUNITOMI. *J. Phys. Soc. Japan*, **7**, 578–83 (*Nov.–Dec.*, 1952).

In a ferromagnetic substance, the origin of internal friction under low stress amplitude has been considered to be due to both macroscopic and microscopic eddy current. The latter has not yet been investigated except in demagnetized state. In this paper, this loss is calculated as a function of magnetization assuming that magnetic anisotropy energy is negligibly small compared with the internal stress energy. The result shows that internal friction increases initially with increase of magnetization but decreases rapidly near the magnetic saturation. The experimental behaviour of internal friction obtained previously can be qualitatively explained by this theoretical result. A.

538.23

1756. Internal friction of ferromagnetic superlattice alloy Ni_3Fe. N. KUNITOMI. *J. Phys. Soc. Japan*, **7**, 584–9 (*Nov.–Dec.*, 1952).

Internal friction of Ni_3Fe is measured as a function of magnetization for different stages of superlattice formation by using transversal vibration of about 500 c/s. For every stage of superlattice formation, the relation of internal friction v. magnetization shows one or two maxima. This behaviour can be explained by considering that one maximum is due to macroscopic and the other due to microscopic eddy current. Using microscopic eddy current theory (preceding abstract), experimental results can be explained by considering internal stress which is closely related to the superlattice formation. A.

538.23

1757. The influence of grain size on coercive force. A. MAGER. *Ann. Phys.* [*Leipzig*] **11**, *No.* 1, 15–16 (1952) *In German.*

Regarding the grains as carriers of nuclei of reverse magnetization a simple relation is deduced giving H_c

as a function of the diameter of the grains, in good agreement with measurements by Yensen and Ziegler (1936). E. P. WOHLFARTH

538.23

1758. Coercive force and magnetocrystalline energy. W. GERLACH. *Z. Phys.*, **133**, *No.* 1–2, 286–90 (1952) *In German.*

Reports measurements of the coercivity of sintered nickel rods. It is found that H_c increases as $K^{1/2}$ on cooling, where K is the anisotropy constant. Similar results were obtained for compact nickel wires. The results are discussed on the basis of Kersten's theory, and the influence of internal strains on the temperature variation of H_c is considered. It is concluded that strain effects preclude a discussion on the basis of Kersten's theory for iron specimens. E. P. WOHLFARTH

538.24

1759. The temperature variation of the magnetization of nickel in low and moderate fields. R. S. TEBBLE, J. E. WOOD AND J. J. FLORENTIN. *Proc. Phys. Soc.* [*London*] *B*, **65**, 858–71 (*Nov.*, 1952).

An account is given of measurements on the reversible changes in magnetization accompanying change in temperature in annealed nickel, and the results are discussed in relation to the work of Bates and others on the temperature changes produced by adiabatic changes in magnetization (the magneto-caloric effect). It is found that at relatively high fields, where the magneto-caloric effect is mainly reversible, the results are in good agreement with those obtained from direct magneto-caloric measurements, while for low field values a quantitative separation of the reversible and irreversible components of the magneto-caloric effect has been carried out. The result of an analysis of the reversible heating effect is compared with the estimate given in the theoretical investigation of Stoner and Rhodes, and it is suggested that, over the low field range considered, rotational processes predominate. A.

538.24

1760. Statistical study of the Barkhausen effect. I. Distribution of domain size. H. SAWADA. *J. Phys. Soc. Japan*, **7**, 564–71 (*Nov.–Dec.*, 1952).

The size distributions of Barkhausen impulses were obtained, at 12 different portions on the hysteresis loop of a Si steel wire, with 7 searchcoils, which had the same turn-density but different coil-lengths from each other. An experimental regularity was found in the relation between the distribution of impulse size and the coil-length. The distribution of domain size was calculated from this regularity, by making some assumptions on the mechanism of Barkhausen effect. The main numerical results obtained are as follows: average length of domain: 0·345–5·20 mm; average volume: $0{\cdot}298–6{\cdot}40\times10^{-5}$ mm^3; average diameter: $3{\cdot}32–3{\cdot}96\times10^{-3}$ mm; minimum average propagating velocity of the magnetic reversal: 3–50 m/sec. A.

538.24

1761. Statistical study of the Barkhausen effect. II. Relation between domain size and internal stress. H. SAWADA. *J. Phys. Soc. Japan*, **7**, 571–4 (*Nov.–Dec.*, 1952).

The numerical values for domain size, obtained in Pt I, were discussed in comparison with the results by Bloch's theory of ellipsoidal domain. It was concluded that the distribution of internal stress plays a leading role in the determination of the remaining position of domain boundary. The distribution of internal stress was determined from the standpoint of the probability theory. Domain size distribution formulae, showing the experimental regularities between the impulse size and the search-coil length, as described in Pt I, were deduced by consideration of the relations between the distribution of internal stress and that of domain boundary. A.

538.24

1762. Statistical study of the Barkhausen effect. III. Distribution of time interval. H. SAWADA. *J. Phys. Soc. Japan*, **7**, 575–8 (*Nov.–Dec.*, 1952).

The time interval distributions of the Barkhausen impulses were investigated. The experimental results show regularities, in contrast with Tyndall's conclusion. An explanation for the experimental result was given, by assuming a simple mechanism for the reversal of domain magnetization. It was concluded that the magnetic reversal is not perfectly accidental, as is the case in the disintegration of radioactive substance. The reversal of domain magnetization always needs some accumulation of energy by magnetic or other effects. A.

538.24

1763. On the a.c. magnetization characteristics of a Perminvar wire. T. HIRONE, H. WATANABE, T. IWATA AND K. IKEDA. *J. Phys. Soc. Japan*, **7**, 593–8 (*Nov.–Dec.*, 1952).

A.C. magnetization characteristics of a Perminvar wire under tension were observed and discussed on the basis of the pipe-domain theory, the results of the discussion being compared with those based on the classical eddy current theory. It was found that the said domain theory would give a semi-quantitative interpretation of the a.c. data, and suggest the existence of an effect other than eddy currents. These results were, in essential, in agreement with the prediction by Williams and others on the a.c. magnetization characteristics of a single crystal of silicon iron. In connection with this, an account was given of an experiment based on the usual technique of estimation of the mean volume of domains and it was found that estimated sizes of the volume had little significance for the a.c. characteristics. A.

538.24

1764. Domain structure near cavities on the surfaces of iron-silicon crystals. B. ELSCHNER. *Ann. Phys.* [*Leipzig*] **11**, *No.* 1, 45–7 (1952) *In German.*

Describes powder pattern experiments on 3% Si–Fe crystals with natural and artificial surface indentations. E. P. WOHLFARTH

538.24 : 539.67

1765. Internal friction of field-cooled ferromagnetic substances. II. 65-Permalloy and Perminvar. N. KUNITOMI. *J. Phys. Soc. Japan*, **8**, 26–30 (*Jan.–Feb.*, 1953).

For Pt I, see Abstr. 7406 (1952). The magnetostriction, internal friction and Young's modulus have

been measured for annealed and field-cooled 65-Permalloy and Perminvar. The magnetostriction shows the degree of the effect of field-cooling. The behaviour of internal friction of 65-Permalloy shows a remarkable difference from that of Ni_3Fe which had previously been observed and explained by the theory considering the rotation of the spontaneous magnetization. It can be explained neither by considering the rotation of the spontaneous magnetization nor by considering the displacement of 180° domain boundaries, so that the other process must be introduced to explain the experimental facts. The internal friction of Perminvar is intermediate in character between Ni_3Fe and 65-Permalloy. It is supposed to be explained by considering both the rotation of the spontaneous magnetization and the other process which is responsible for the internal friction of 65-Permalloy. The change of Young's modulus by the magnetization is consistent with that of internal friction. A.

538.244.2 : 621.318.43.042.3

1766. Magnetization of toroids with one and two cuts. F. F. Panesenkov. *Zh. tekh. Fiz.*, **22**, *No.* 6, 989–99 (1952) *In Russian.*

A method of calculating the leakage coefficient of toroids with a large gap (cut) is presented and used for establishing an empirical formula for calculating the average leakage coefficient for toroids with one and two diametrically opposed gaps. Furthermore, the mean magnetic permeability of a toroid with gap was determined and the coefficient of self-inductance of such a toroid calculated. Satisfactory agreement between experimental and theoretical values is demonstrated and practical applications of the formulae obtained are suggested. A possible application is to the calculation of field strengths in air gaps of transformers, reactors and electromagnets with annular cores. The empirical formula is correct for magnetizations $100 < I < 1000$ and for air gaps $d < r$, in the case of two air gaps, for $d < 3r$ (where d, d_i width of air gap; r radius of toroid). B. F. KRAUS

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

1767. Angular momentum in Dirac's new electrodynamics. R. W. Iskraut. Letter in *Nature* [*London*] **170**, 1125–6 (*Dec.* 27, 1952).

Tyabji's symmetrical tensor [Abstr. 8945 (1952)] is interpreted as containing a "matter" term and the corresponding angular momentum contains field and "matter" components. R. A. NEWING

538.3

1768. The energy momentum tensor in Dirac's new electromagnetic theory. B. Hoffmann. Letter in *Nature* [*London*] **170**, 1126 (*Dec.* 27, 1952).

Tyabji's symmetrical tensor for Dirac's vortical theory is obtained directly by variation of a Lagrangian with respect to the $g_{\mu\nu}$. R. A. NEWING

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561 : 621.396.615

1769. Power spectrum of a non-linear oscillator whose amplitude-frequency relation is disturbed by noise. A. Blaquière. *C.R. Acad. Sci.* [*Paris*] **235**, 1201–3 (*Nov.* 17, 1952) *In French.*

The method of Abstr. 3257 (1952) is extended to the case of an oscillator in which amplitude and frequency are not independent. Expressions for the correlation function and spectral density are given. G. D. SIMS

538.561 : 621.396.615.14

1770. A wide range oscillator of high stability. D. E. Caro and L. U. Hibbard. *J. sci. Instrum.*, **29**, 403–8 (*Dec.*, 1952).

A beat-frequency oscillator tuning continuously from 0·25 to 10 Mc/s is described. The oscillator uses quarter-wave coaxial lines as the resonant elements and is tuned by a single rotating condenser. The frequency as a function of condenser shaft angle is reproducible to an accuracy better than 0·03% throughout the frequency range. A.

538.565 : 621.3.018.75 : 621.317.35

1771. Analysis of impulses by means of resonators. A. A. Kharkevich. *Zh. tekh. Fiz.*, **21**, 886–91 (*No.* 8, 1951) *In Russian.*

It is shown mathematically that a set of resonators (preferably with zero damping) can be used for analysing aperiodic phenomena and formulae are derived for error determination. As example, an analysis of a rectangular impulse is considered.

A. GELBTUCH

538.566 532.59

On solutions to the wave equation in hyperbole space. *See Abstr.* 1413

538.566 : 537.525.9

Electromagnetic properties of plasmas. *See Abstr.* 1668

538.566 : 537.533.7

1772. Propagation in electron-ion streams. R. Q. Twiss. *Phys. Rev.*, **88**, 1392–407 (*Dec.* 15, 1952).

A mathematical theory is given for the propagation of electromagnetic waves in electron-ion streams composed of N discrete beams. The solution, which is fully relativistic, is obtained in vector form by an extension of Hansen's theory and takes explicit account of the initial and boundary conditions. When certain restrictions are placed upon the transverse boundary conditions the general solution satisfying arbitrary initial conditions can be expanded in terms of a complete orthogonal set of elementary vector solutions. For this case the necessary and sufficient conditions are found for amplification and instability both in the terminated and the unterminated stream. The correct physical interpretation of the conventional "Ansatz" solutions is found together with the conditions under which they are valid. One is then able to distinguish amplified growing waves from reverse waves attenuated in the reverse direction. Finally the analysis is extended to the continuous velocity distribution. It is shown

that the present treatment differs significantly from Landau's theory for the thermal plasma and the consequences of this are discussed. A.

538.566 : 621.392.2 : 621.396.11

1773. Diffraction of electromagnetic waves by openings in plane conducting sheets. J.-P. VASSEUR. *Onde élect.*, **32**, 97–111 (*March*, 1952) *In French.*

Huyghen's principle is expressed as integral equations valid for a hole in a plane metal sheet. It is shown that the application of this principle is useful in certain cases where Maxwell's equations can mislead. When applied to large holes the present approach agrees with that of Kottler. An experimental study was made of the field along the axis of circular slots of various diameters. The resulting data were in better agreement with the present theory than with those of Kottler and Severin. An extensive bibliography started in Abstr. 5206 (1952) is concluded. See also Abstr. 5205 (1952) for beginning of paper. W. T. BLACKBAND (R)

538.566

1774. The absorption and reflection of microwave radiation by a mercury-vapour discharge. H. A. PRIME. *Austral. J. sci. Res. A*, **5**, 592–606 (*Dec.*, 1952).

The power transmission and reflection coefficients of a limited volume of ionized gas (a mercury-vapour discharge) located within a waveguide have been measured at a frequency of approximately 10 000 Mc/s by a microwave method. From these coefficients the real and imaginary components of the complex conductivity of the discharge are evaluated. The results show that the real component of the conductivity σ_r, is a linearly increasing function of the discharge current, whereas the rate of increase of the imaginary component σ_i which is negative, decreases with increasing discharge current. The ratio σ_i/σ_r decreases with increase in current, but is of the order of unity due to the fact that the gas pressure is sufficiently high ($\sim$1 atm.) to make σ_r comparable with σ_i. The theoretical basis of the work is presented in an appendix in which the particular case of high pressure conditions is discussed. A.

538.566

1775. The microwave admittance of a mercury-vapour discharge. H. A. PRIME. *Austral. J. sci. Res. A*, **5**, 607–17 (*Dec.*, 1952).

The normalized conductance and susceptance of a low-pressure mercury-vapour discharge have been measured as a function of the discharge current at a frequency of *c.* 10 000 Mc/s by a microwave method. The complex conductivity of the discharge is then calculated from the admittance data by representing the discharge as a shunt admittance loading the waveguide. The validity of this approximate representation is examined. The conductivity results are in agreement with similar published results and the similarity between the characteristics of a d.c. sustained discharge and a radio-frequency discharge are noted. It is deduced that the collision frequency varies only slowly with change in discharge current. See also preceding abstract. A.

538.566

1776. Diffraction of electromagnetic waves by an aperture in an infinite screen. G. BEKEFI. Letter in *J. appl. Phys.*, **23**, 1403 (*Dec.*, 1952).

For apertures large compared to the wavelength the approximate expression for the Hertz vector

$$\pi_x = \frac{1}{2\pi}\int\left(\frac{\partial \pi_x^i}{\partial z}\right)_{z=0}\frac{e^{-ikr}}{r}dS$$

was found to be in good agreement with measurements made within and behind the aperture. The integral is taken over the aperture, the electric field of the incident radiation is along the x-axis, the superscript i denotes the incident field. L. PINCHERLE

538.566

1777. Reflection of electromagnetic waves obliquely from an inhomogeneous medium. J. R. WAIT. Letter in *J. appl. Phys.*, **23**, 1403–4 (*Dec.*, 1952).

Theoretical, for the case in which the electric vector is perpendicular to the plane of incidence and the permittivity is taken to vary exponentially. The expression obtained for the reflection coefficient involves Bessel functions. L. PINCHERLE

538.566

1778. Diffraction field of a circular aperture. G. A. WOONTON. Letter in *J. appl. Phys.*, **23**, 1405–6 (*Dec.*, 1952).

A semi-empirical formula is given, which was found to be in very good agreement with experiment for apertures 7–8 wavelengths in diameter. L. PINCHERLE

538.566

1779. A new method of solving diffraction problems. H. E. J. NEUGEBAUER. Letter in *J. appl. Phys.*, **23**, 1406 (*Dec.*, 1952).

The approximations used are: (1) The e.m. field is assumed to be that given by the laws of geometrical optics. (2) The field is represented by a Hertz vector π, E being computed from it after the second approximation of π has been found. The mathematics is similar to that used by Franz [see Abstr. 866 (1950)]. Results for diffraction at a circular aperture are in agreement with experiment. L. PINCHERLE

538.566 534.26

Removal of an inconsistency in the theory of diffraction. *See Abstr.* 1464

538.566 : 621.396.11

1780. Some experiments on centimeter-wavelength scattering by small obstacles. N. R. LABRUM. *J. appl. Phys.*, **23**, 1320–3 (*Dec.*, 1952).

The scattering has been measured in several cases which are of interest in connection with the interpretation of radar echoes from rain and cloud formations. The measurements were made at 3000 Mc/s by an impedance-bridge technique, the specimens being contained in a wave guide. The results verify the theoretical relationship between the size of the scatterer and the intensity of the backscattered wave. Observations have also been made of the variation in scattering during the melting of an obstacle initially composed of ice. In this case, it was not possible to simulate exactly the conditions of large-scale meteorological phenomena; however, the experiments demonstrate qualitatively that, as had been predicted, the power backscattered from an initially nonspherical ice particle passes through a maximum value during the transition to a water drop. A.

538.566 : 621.396.11

1781. The scattering of radio waves by meteorological particles. N. R. LABRUM. *J. appl. Phys.*, **23**, 1324–30 (*Dec.*, 1952).

Scattering by clouds of small spheroidal obstacles is considered from a theoretical standpoint. Numerical data are obtained for the case of clouds composed of partly melted ice particles. These results are applied to interpret "bright band" radar echoes from meteorological formations. It is also shown that these echoes may contain a component with polarization at right angles to that of the transmitted beam. It is suggested that this property could be utilized in certain cases to provide additional information as to the nature of the scattering particles. A.

538.566

1782. Particle properties of radiant energy in wave guides. W. R. RAUDORF. *Amer. J. Phys.*, **21**, 25–8 (*Jan.*, 1953).

The mean energy per excitation wavelength of e.m. radiation propagated along a lossless uniform waveguide is found to be $w = Qv$, Q being independent of frequency for a given amplitude of the longitudinal field intensity, mode of the field, and structure of the guide. The frequency v and the group velocity v_g of the radiant energy are related by the equation $v/v_c = [1 - (v_g/c)^2]^{-\frac{1}{2}}$, where $v_c = c/\lambda_c$ denotes the frequency at cutoff, λ_c the excitation wavelength at cutoff. This equation permits one to put $hv = hv_c + hv_c\{[1 - (v_g/c)^2]^{-\frac{1}{2}} - 1\}$. The amplitudes of the field intensities are chosen such that Q equals Planck's constant h. Applying the mass-energy relation, the term $hv_c = hc/\lambda_c = m_0c^2$ may be interpreted as the "potential" (=rest) energy of the quantum hv and m_0 as the rest mass. The momentum p associated with hv is found to be $p = h/\lambda_g$, λ_g being the wavelength along the guide. When radiant energy passes from one guide into another one of different cross-sectional structure via a tapered piece of waveguide, a partial conversion of "potential" to "kinetic" energy, and vice versa, occurs along the tapered section. In the case of TEM waves, which, however, can only be supported in a guide of infinite transverse dimensions, the group velocity becomes c and the rest mass zero. A.

538.566 : 621.392.26

1783. Calculation of the propagation constants of an inhomogeneously-filled waveguide. J. A. BRADSHAW; L. G. CHAMBERS. Letters in *Brit. J. appl. Phys.*, **3**, 332–3 (*Oct.*, 1952).

Bradshaw gives a variational approach to the problem which he considers more direct than that used by Chambers [Abstr. 2855 (1952)]. Chambers replies. G. D. SIMS

538.566 : 621.392.26 : 621.396.677

1784. Second-order beams of slotted wave guide arrays. H. GRUENBERG. *Canad. J. Phys.*, **31**, 55–69 (*Jan.*, 1953).

It is shown that the radiation pattern of slotted waveguide arrays may contain small second-order beams even for slot spacings less than a free-space wave length. These beams are usually split with a minimum or even a null in the plane containing the array and main beam. Since patterns are normally taken in this plane, the second-order beams have until now escaped attention, as far as the writer is aware. Methods of suppressing these beams are discussed. A.

538.566 : 621.396.671

1785. Radiation from a horizontal dipole in a semi-infinite dissipative medium. R. H. LIEN. *J. appl. Phys.*, **24**, 1–4 (*Jan.*, 1953).

Expressions for the electric field due to an oscillating horizontal dipole placed in a semi-infinite dissipative medium have been derived for the case when the frequency is low. The main work involves the evaluation of some complex integrals which have been reduced to forms suitable for numerical computation. A.

538.566.2 : 621.396.11

1786. A method of solving the wave equation in a region of rapidly varying complex refractive index. J. J. GIBBONS AND R. L. SCHRAG. *J. appl. Phys.*, **23**, 1139–42 (*Oct.*, 1952).

A process is described whereby the complex wave equation is transformed into an integro-differential equation in a single real dependent variable. This makes possible a technique for obtaining wave functions, which is believed to offer definite advantages in some instances where the more standard methods are difficult to handle, e.g. in regions where the complex index is varying rapidly. The index may be entered in a tabulated form, and its exact analytical expression is not required. The technique is then demonstrated by computing the reflection coefficient associated with an extremely critical region, that which one encounters at the "fourth reflection condition," where the refractive index goes through a sharp peak. A.

538.566.2 : 551.594.221

1787. On the propagation of very long electric waves and the wave spectrum of the lightning discharge. W. O. SCHUMANN. Note in *Naturwissenschaften*, **39**, *No.* 20, 475 (1952) *In German.*

Assuming a rectangular impulse, representing the lightning current, being radiated from an antenna, the propagation of the resulting waves is evaluated by using Watson's formula (1919) under consideration of reflections from the ionosphere. This results in a signal intensity the amplitude of which decreases with the cube of the distance and which is broadened proportionally to the square of the distance. R. H. GOLDE

538.566.2 : 551.594.6 : 621.396.11

1788. The propagation of a radio atmospheric. II. K. G. BUDDEN. *Phil. Mag.*, **43**, 1179–1200 (*Nov.*, 1952).

In Pt I [Abstr. 2863 (1951)] an outline of the theory was given for the case when the top surface of the waveguide was the boundary of a homogeneous ionized medium, and the earth's magnetic field was neglected. The present paper gives the full mathematical theory, and shows how the characteristics of the waveguide modes may be determined in the most general case, provided that the reflecting properties of the earth and the ionosphere are known as functions of the angle of incidence which is, in general, complex.

t is found that the waveguide modes are of two types, which are described as "quasi-transverse magnetic" nd "quasi-transverse electric." Allowance can be nade for the curvature of the earth. A particular ase is then discussed, in which the surface of the arth is assumed to be perfectly conducting, and the onosphere is assumed to be a homogeneous ionized nedium, with the steady magnetic field of the earth uperimposed. The results of numerical calculations re given, for a few special cases, in the form of urves. These show (1) the attenuation in the various nodes as a function of frequency, (2) the polarization haracteristics of the wave in typical modes, and (3) the amplitudes of the waves which are excited in ypical modes by a vertical electric dipole source. A.

538.566.3 : 551.594.6

1789. Experimental determination of resonance curves in the motion of slow electrons of the upper atmosphere. M. CUTOLO. *Nuovo Cimento*, **9**, 391–406 (*May*, 1952) *In Italian.*

Bailey's theory (1937) of gyrointeraction shows that according to the penetration in the E layer (which begins at about 90 km from the surface of the earth) of the unmodulated wave, one may obtain different resonance curves by varying the frequency of the carrier of the modulated station around the gyrofrequency. If the penetration of the wanted wave exceeds 4 km one gets a resonance curve with two maxima instead of one. Experiments made in Italy in 1949 to obtain curves of resonance with two humps are briefly described. During the experiments on gyrointeraction made in Italy in 1948 and 1949 an appreciable influence of the sunspots on the phenomenon was observed. The authors have made new experiments in 1950 to obtain curves of resonance with one hump. By varying the frequency of the unmodulated station (Taranto), it was possible to pass from a curve with two humps to a curve with one hump. A.

538.566.3 : 621.396.11

1790. Calculation of sky-wave field strength. K. RAWER. *Wireless Engr*, **29**, 287–301 (*Nov.*, 1952).

This is carried out by separately evaluating the contribution of each possible path of ionospheric propagation between the transmitter and receiver, and then combining the results. The method involves calculating the losses in any given path, for which purpose formulae have been derived. These losses are due to the influence of geometrical optics on an expanding bundle of rays; to the non-selective absorption in the D-layer; to the selective absorption in the E-layer; and to partial reflection in the E_s-layer. The number of possible paths is stated, and the limiting usable frequencies for these paths are also taken into account. A formula is built up expressing the resultant field-strength due to the contribution from each of these separate paths, but, since the polarization and phase of the waves in these paths may vary considerably, this formula is modified by deriving an average value for these variables over a period of some minutes. A comparison is made between this method and the C.R.P.L. method of 1948, for long, medium and short distances. The article concludes with a bibliography of 30 references. A. A. LINSELL (R)

538.566.3 : 621.396.11

1791. The theory of the limiting polarization of radio waves reflected from the ionosphere. K. G. BUDDEN. *Proc. Roy. Soc. A*, **215**, 215–33 (*Nov.* 25, 1952).

Discusses the coupling which occurs in the lower part of the ionosphere. Here there is a "limiting" region where a downcoming characteristic wave acquires the limiting polarization observed at the ground. Booker (1936) gave an approximate specification for the level of the limiting region. This paper gives a more precise specification and develops a method for calculating the limiting polarization of a downcoming characteristic wave. The theory is based on Försterling's (1942) coupled wave equations, which apply only to vertical incidence. They contain a coupling parameter, ψ, which depends on the gradients of electron density and collision frequency. The level of the limiting region is specified in terms of ψ and the refractive indices of the characteristic waves. The properties of a specific model of the ionosphere are discussed, and it is shown that for frequencies greater than about 1 Mc/s the limiting polarization is that given by the magneto-ionic theory for a certain "limiting point" which occurs at a definite value of the height. This value may in general be complex, but in practical cases is almost purely real and occurs where the electron density and collision frequency are small, so that at high frequencies the limiting polarization is determined only by the magnitude and direction of the earth's magnetic field in the ionosphere. A.

MAGNETIC EFFECTS 538.6

538.61

1792. The Faraday effect in deuterium and certain other gases. L. R. INGERSOLL AND W. L. JAMES. Letter in *J. Opt. Soc. Amer.*, **42**, 985 (*Dec.*, 1952).

Describes experiments on the Verdet constant of deuterium, oxygen, helium and several vapours, some of the measurements being made under several vapour pressures. The preliminary value for deuterium is $6{\cdot}1\times10^{-6}$ for Na light at 0°C.

E. P. WOHLFARTH

538.632

1793. Hall effect in zinc crystals at low temperatures. J. K. LOGAN AND J. A. MARCUS. *Phys. Rev.*, **88**, 1234–8 (*Dec.* 15, 1952).

For each crystal, one component of the Hall field was measured for a fixed crystallographic orientation of the current density, but for various orientations of the magnetic field in the plane perpendicular to the current density. At 77°K, the Hall field is a linear function of magnetic field which can be characterized by two coefficients. The first coefficient, for the interaction between the magnetic field component parallel to the hexagonal axis and current density component in the hexagonal plane, has a value of about 2×10^{-12} ohm cm/gauss. The second coefficient measures the interaction between the magnetic

field component in the hexagonal plane and the current density component perpendicular to this field component. Its value is about $0{\cdot}2\times10^{-12}$ ohm cm gauss. At 20·4°K, the Hall field is nonlinear with magnetic field. For some orientations, the measured component of the Hall field increased with increasing magnetic field. In other cases, the opposite behaviour was observed. Between 5 and 10 kilogauss, the Hall effect is of the same order of magnitude at 20·4°K as at 77°K. No correlation was apparent between Hall effect and either susceptibility or magneto-resistance. A.

538.632

1794. The Hall effect of copper nickel alloys. A. I. Schindler and E. M. Pugh. *Phys. Rev.*, **89**, 295–8 (*Jan.* 1, 1953).

The ordinary and extraordinary Hall effects have been measured at room temperatures for the N — Cu series of alloys. The number of conduction electrons calculated from $n^* = 1/R_0 Ne$ (where R_0 is the "ordinary" constant measured at high fields) agrees fairly well with the number of 4*s* electrons predicted for the alloys from the simple band model. It is shown that the agreement for these alloys should improve at lower temperatures. Results in pure Ni and Cu do not agree so well. A two-band model is invoked to explain the ordinary effect in pure Ni. Since in pure Cu the 4*s* band is half full, the simple approximation, valid for nearly empty bands, should not be expected to hold. No explanation is offered for the extraordinary Hall effect in any of the samples. A.

538.639 : 537.323

On the magneto-thermoelectric power of iron crystal at low temperatures. *See Abstr.* 1650

538.652

1795. Magnetostriction of single crystals of cobalt and nickel ferrites. R. M. Bozorth and J. G. Walker. Letter in *Phys. Rev.*, **88**, 1209 (*Dec.* 1, 1952).

For a crystal of $Co_{x-y}Fe_{2-x}O_4$ cut as a disk parallel to the (001) plane, $\Delta l/l$ in the [100] direction was found to be -540×10^{-6}, 720×10^{-6} after magnetic annealing, the values corresponding to saturation conditions. Measurements were also made for two $Ni_xFe_{3-x}O_4$ specimens. For the Co ferrite $\lambda_{100} = -515$, $\lambda_{111} = 45$, for the Ni ferrite $\lambda_{100} = -36$, $\lambda_{111} = -4$, all in units 10^{-6}. E. P. Wohlfarth

538.69 : 535.214

1796. Researches on magnetophotophoresis. L. Steiff. *Acta. phys. Austriaca*, **6**, *No.* 1, 1–6 (1952) *In German.*

The particles used were γ–Fe_2O_3 of size about 10^{-4} to 10^{-5} cm, obtained by striking an iron arc in air. The curve of particle velocity against light intensity was monotonously increasing and convex upwards. There is no significant difference between the effects of u.v., visible or i.r. light. The particle velocity increases with the magnetic field up to a saturation value of about 2×10^{-2} cm/sec. Some particles behaved like north poles, others like south poles, and at small magnetic fields the Brownian movement became appreciable. N. Corcoran

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.1

1797. Some investigations in the field of the theory of solids. III. Plane and space lattice of similar atoms. T. A. Hoffmann. *Acta. phys. Hungar.*, **2**, *No.* 2, 97–106 (1952).

For Pt II, see Abstr. 836 (1952). The "linear combination of atomic orbitals" approximation of the molecular orbital method is used to calculate the energy of a square plane and a simple cubic space crystal built up of atoms of one kind. In this approximation the energy is given by the Coulomb, exchange and overlap integrals of neighbouring atoms. The comparison of the chain, plane and space cases suggests conclusions as to the density of states in the band in the respective dimensions. A.

539.1

1798. Some investigations in the field of the theory of solids. IV. A-B-type ordered binary systems in the plane and the space. T. A. Hoffmann. *Acta. phys. Hungar.*, **2**, *No.* 2, 107–27 (1952).

A mathematical method similar to that in Pt III is used to calculate the *A–B* type ordered systems in the plane and in the space, for simple square and simple cubic lattices. The stability of the structure against dissociation is discussed in the chain-plane-space sequence and thus conclusions can be drawn as to the occurrence of crystals in the respective dimensions. The band scheme is discussed for the cases of vanishing and non-vanishing overlap integrals. A.

539.11

1799. A theory of the deviation from close packing in hexagonal metal crystals. J. B. Goodenough. *Phys. Rev.*, **89**, 282–94 (*Jan.* 1, 1953).

A mechanism is proposed to show how the Fermi surface interacts with the Brillouin zone boundaries. The direction and relative magnitude of the variation of the *c/a* ratio for hexagonal crystals from the ideal value for close packing are predicted as a function of the electron-atom ratio, and these predictions are compared with values of lattice parameters which are reported in the literature. A.

539.11

1800. On a non-linear approximation of the inter-atomic force in solid. J. Soma and M. Ogi. *J. Phys. Soc. Japan*, **8**, 6–8 (*Jan.–Feb.*, 1953).

A new non-linear approximation is taken for the interatomic force in a solid. The thermal expansion of some materials is calculated, and good agreement with experiment found. It is shown that using this non-linear potential conserves the type of partition function of the linear model. A.

539.11 : 547.113

1801. The effect of neutron bombardment on the low temperature atomic heat of silicon. P. H. Keesom, K. Lark-Horovitz and N. Pearlman. *Science*, **116**, 630–1 (*Dec.* 5, 1952).

Neutron bombardment disorders the silicon lattice, producing defects which trap free electrons and holes.

e low temperature atomic heat (at 5°K) is measured fore and after bombardment and then after anneal- at various temperatures. The production of tice disorder lowers the contribution of the lattice the atomic heat and trapping of free carriers ers their respective contributions. The Debye nperature also shows changes under the above ditions. G. F. J. GARLICK

539.11 : 541.183

Some investigations in the field of the theory of solids. Adsorption. Surface states. *See Abstr.* 2032

MOLECULAR STRUCTURE 539.13

539.13

02. A free-electron model for π-molecular complexes. K. E. SHULER. *J. chem. Phys.*, **20**, 1865–71 (*Dec.*, 1952).

The free-electron model for conjugated molecules extended to a discussion of molecular complexes rmed from conjugated molecules (π-molecular mplexes). The forces responsible for complex rmation are identified as "π-delocalization" forces. π stability and the absorption spectra of these mplexes are discussed for a linear, one-dimensional odel. The influence of hydrostatic pressure on the sition of the complex absorption spectrum is con- dered, and some predictions are made regarding the ulting shifts of various absorption peaks. The e-electron model is compared with the models ggested by other workers, and good agreement is und in regard to the factors governing the formation d spectra of molecular complexes. A.

539.13 : 534.23

Energy transfer by collisions in *cis*- and *trans*-dichloroethylene vapors. *See Abstr.* 1457

539.132

03. Thomas–Fermi fields for molecules with tetrahedral and octahedral symmetry. N. H. MARCH. *Proc. Cambridge Phil. Soc.*, **48**, *Pt IV*. 665–82 (1952).

The Thomas–Fermi method has been applied to olecules with tetrahedral or octahedral symmetry in e approximation in which the nuclei of the outer ons are smeared out over the surface of a sphere. lutions are given for the molecules CH_4, CF_4, CCl_4, H_4, SiF_4 and SF_6, and using the results presented re it will not be a difficult matter to obtain the lutions for other molecules if they should be quired. A comparison of the results for CH_4 with ose of Buckingham, Massey and Tibbs (1941) shows at whilst for such a light molecule the charge tribution is somewhat poor, the potential is already good agreement with the results of the Hartree lf-consistent field method. For CCl_4, however, the proximation of smoothing out all the protons pears to break down. An alternative approxima- n in which the K and L shell electrons are com- essed into the nucleus and the modified nuclear arges smoothed, has been investigated and appears give more reasonable results. A discussion of the ergy has been given, but the method is not suffi- ntly accurate to be of value for energetic con- derations. A.

539.132 : 536.7 : 535.375.5

The structure, force constants, and thermodynamic properties of bromine pentafluoride. *See Abstr.* 1551

539.132

1804. Substituted methanes. IX. Raman and infrared spectra, assignments, potential constants, and calculated thermodynamic properties for $CHClBr_2$ and $CDClBr_2$. A. PONTARELLI, A. G. MEISTER, F. F. CLEVELAND, F. L. VOELZ, R. B. BERNSTEIN AND R. H. SHERMAN. *J. chem. Phys.*, **20**, 1949–54 (*Dec.*, 1952).

For Pt VIII, see Abstr. 3770 (1952). Raman displacements, semiquantitative relative intensities and quantitative depolarization factors for liquid states, and infrared wave numbers and per cent transmission curves for both the liquid and gaseous states in the region 400–4300 cm^{-1} were obtained and compared with previous data. A normal coordinate treatment (Wilson *FG* matrix method) was carried out, and a consistent set of potential constants for both molecules was determined, using a potential energy function containing all possible 2nd degree terms. Assignments were made for all observed bands. The heat content, free energy, entropy and heat capacity at constant pressure were calculated for 12 temperatures from 100° to 1000°K. A.

539.132

1805. Substituted methanes. XI. Potential constants for CBr_2Cl. A. G. MEISTER AND F. L. VOELZ. *J. chem. Phys.*, **21**, 158 (*Jan.*, 1953).

For Pt IX, see preceding abstract. A new set of potential constants has been obtained for CBr_2Cl using the Wilson FG matrix method and a potential energy function containing all possible second degree terms. These constants are in better agreement with those determined for CBr_2Cl_2, CBr_2ClH, CBr_2ClD and CCl_2Br than the set given previously. A.

539.132

1806. Molecular constants of cesium chloride by the molecular beam electric resonance method. R. G. LUCE AND J. W. TRISCHKA. *J. chem. Phys.*, **21**, 105–9 (*Jan.*, 1953).

The electric resonance method of molecular beam spectroscopy was used to observe the CsCl spectra arising from transitions of the type $J, m_J \rightarrow J, m'_J$, where J is the rotational quantum number and m_J the electric quantum number. The following transitions were identified and studied: 2,0→2,1; 3,0→3,1; 4,0→4,1; 4,1→4,2; and 5,1→5,2. An analysis of the spectra for several values of the electric field intensity gave the following molecular constants for the ground vibrational state of $Cs^{133}Cl^{35}$: $\mu_0 = 10{\cdot}46 \pm 0{\cdot}14$ debye; $A_0 = (385 \pm 9) \times 10^{-40}$ gm cm^2; $B_0 = (72{\cdot}7 \pm 1{\cdot}7) \times 10^{-3}$ cm^{-1}; $r_0 = (2{\cdot}88 \pm 0{\cdot}03) \times 10^{-8}$ cm μ_0 is the electric dipole moment, A_0 is the moment of inertia, B_0 is the rotational constant and r_0 is the internuclear distance. If μ is assumed to be proportional to the internuclear distance, and if the potential function is assumed to be a cubic, then the vibration-rotation constant α_e is calculated to be $(0{\cdot}53 \pm 0{\cdot}08) \times 10^{-3}$ cm^{-1}. From measurements of line widths it was possible to set upper limits on the quadrupole interaction constants of Cs and Cl; viz. $|eqQ/h|_{Cs} \leqslant 4$ mc/sec and $|eqQ/h|_{Cl} \leqslant 3$ Mc/s. A.

539.132

1807. Some methods of determining molecular constants. D. H. RANK. Letter in *J. chem. Phys.*, **20**, 1975–6 (*Dec.*, 1952).

A set of least mean squares equations is given from which the constants of the P and R branches of diatomic rotational bands may be determined. The accurate rotational constants derived by microwave spectroscopy for the ground state allows those of excited states to be determined by this method. The method is considered by application to fragmentary bands where, owing to a large number of missing lines, only a small number of $\Delta_2 F$ can be obtained, and to the case where B'' for the ground state has been determined with microwave accuracy. A B' may be calculated for each line and a correct constant B' determined from the values so obtained.

H. H. GREENWOOD

539.132

1808. The C = O valence vibration and the Hammett constant in a series of benzophenones. M.-L. JOSIEN, N. FUSON AND D. E. PEARSON. *C.R. Acad. Sci.* [*Paris*] **235**, 1206–7 (*Nov.* 17, 1952) *In French.*

See also Abstr. 5964 (1952). A considerable number of different benzophenones were dissolved in CCl_4 and i.r. spectra were taken. It is found that the frequencies of the C = O valence vibrations vary linearly with the reduction potentials and also with the Hammett constants. The latter has also been observed for substituted quinones. A. J. TAYLOR

539.132

1809. The complete symmetry group for internal rotation in CH_3CF_3 and like molecules. H. T. MINDEN. *J. chem. Phys.*, **20**, 1964–5 (*Dec.*, 1952).

The symmetry for the wave functions of molecules like CH_3CF_3 is analysed, and a new group, C_9, is proposed. The irreducible representations in C_9 are derived in the general case for the nuclear spin and internal rotation factors of the wave function. The procedure is described for determining the symmetry and statistical weight of any given internal rotation-vibration energy level. A.

539.132

1810. Vibration potential function of the ClO_2 molecule. J. DUCHESNE AND A. H. NIELSEN. Letter in *J. chem. Phys.*, **20**, 1968–9 (*Dec.*, 1952).

Recent electron diffraction and infrared bond-length and bond-angle data are used to determine the four unknown force constants appearing in the general quadratic potential function. The three observed fundamental frequencies are not sufficient to fix the four constants uniquely. The interdependence between pairs is plotted graphically from the frequency data by a method introduced earlier by Duchesne. A choice may then be made of the most reliable set of four interrelated values.

H. H. GREENWOOD

539.132

1811. Internal rotation in dichlorobutine. Y. MORINO, I. MIYAGAWA AND A. WADA. Letter in *J. chem. Phys.*, **20**, 1976–7 (*Dec.*, 1952).

Hindered rotation is observed in noting the increase of dipole moment with increase of temperature. Since the steric repulsion between the widely separated CH_2Cl groups must be quite small, and the central triple bond places no hindrance on rotation, the hindering potential must be mainly due to electrostatic forces. The potential barrier, assuming an electrostatic form, is calculated to be $V_0 = 0{\cdot}75 \pm 0{\cdot}20$ kcal. Alternatively, assuming the C–Cl and C–H bond moments to be 1·5D and 0·4D respectively, each corresponding dipole being situated at a distance 0·77Å, the radius of the carbon, from the adjacent C atom, the calculated value of $V_0 = 0{\cdot}5$ kcal is obtained, confirming with sufficient accuracy the electrostatic interpretation. The abnormally high dipole moment observed for dichloroethane in benzene solution, attributed to molecular association, is not observed here. It is suggested that the separation of the two chlorine atoms, being larger than the benzene diameter, would not favour this type of association. H. H. GREENWOOD

539.132

1812. Interactions in vibrating molecules. P. TORKINGTON. *J. chem. Phys.*, **21**, 83–7 (*Jan.*, 1953).

Theories of the origin of interactions in the vibrational potential function are briefly discussed. It is concluded that the present accepted theory, based on the assumption of orbital hybridization changes, and van der Waals' forces between nonbonded atoms, is in need of some modification. Consistent results are obtained if the orbital amplitude, directly relatable to the valence angle, is employed as the parameter deciding signs of interactions, the determining factor then being the energy increment in the system of oscillating bonds, relative to the increment without change of amplitude. This puts the orbital valence theory of dynamic interactions on a more fundamental basis. A.

539.132

1813. The influence of vibration on forbidden electronic transitions. H. SPONER AND K. F. HERZFELD. *Z. Phys.*, **133**, *No.* 1–2, 41–7 (1952) *In German.*

In molecules with high symmetry certain otherwise forbidden transitions become allowed in virtue of nuclear vibrations. The benzene absorption at 2600Å is of this nature. There are 2 effects: (*a*) the nuclei are displaced, (*b*) the coefficients of the electronic wave functions are changed. Effect (*a*) is calculated and found to be far too small to give the observed intensity. W. J. SWIATECKI

539.132

1814. Magnetic hyperfine structure in diatomic molecules. R. A. FROSCH AND H. M. FOLEY. *Phys. Rev.*, **88**, 1337–49 (*Dec.* 15, 1952).

A general theory of the magnetic hyperfine structure in diatomic molecules, including states other than $^1\Sigma$ states, is given. The magnetic hyperfine interaction is derived from the Dirac equation for the electron in the molecular potential field. First-order hyperfine structure formulae are given for the various vector coupling schemes characteristic of molecular states. The $^1\Sigma$ magnetic hyperfine structures are obtained from second-order hyperfine interactions. Applications to the $N^{14}O^{16}$ and $O^{16}O^{17}$ microwave spectra are discussed. A.

539.132

1815. On the valence theory of the methyl radical. T. Itoh, K. Ohno and M. Kotani. *J. Phys. Soc. Japan*, **8**, 41–9 (*Jan.–Feb.*, 1953).

The electronic structure of the ground state of CH_3 is investigated by the Heitler–London–Slater–Pauling method extended by Voge and Kotani and Siga. The wave functions are constructed without assuming the electron pair bond and taking $(2s)^2(2p)^2$, $(2s)(2p)^3$ and $(2p)^4$ configurations of the carbon atom into account. Assuming a pyramidal model for this radical, seventeen $^2A_1$ states are obtained. The energy matrix for these states is computed by means of the representation matrices of the symmetric group. Solving the secular equation thus obtained for various values of the apex angle, the most stable configuration is found to be slightly nonplanar. The electron pair bond approximation is shown to be fairly good in the cases when $\angle HCH = 120°$ and $109·5°$ (sp^2 and sp^3 hybridization), but it becomes very poor for $\angle HCH = 90°$ (pure p bond). A.

539.132 : 535.343.2

Direct evidence for the $n \rightarrow \pi$ electronic transition of the nitroso-absorption. *See Abstr.* 1515

539.132

1816. Electronic orbitals, shapes and spectra of polyatomic molecules. A. D. Walsh. Letter in *Nature* [*London*] **170**, 974–5 (*Dec.* 6, 1952).

Molecular orbitals for 2 possible shapes of a particular molecule were chosen; and by varying a parameter from its value in one shape to that in the alternative form a correlation of orbitals was obtained. From this the most stable shapes for any electron configuration, together with possible vibrations, were deduced. J. JACOBS

539.132

1817. On the exchange terms in the HLSP theory of an n-electron molecule. K. Nukasawa. Letter in *J. chem. Phys.*, **20**, 1983 (*Dec.*, 1952).

If simple exchange terms due to all orbitals are considered, the group state energy of butadiene is found to within $\pm 0·3$ eV of the accurate value.

J. JACOBS

539.132

1818. The electronic structure of ferrocene. H. H. Jaffé. *J. chem. Phys.*, **21**, 156–7 (*Jan.*, 1953).

The electronic structure of ferrocene (*bis*cyclopentadienyl iron) is considered by constructing MO's from the AO's of the iron atom and the MO's of the cyclopentadienyl radicals. The 18 valence electrons of the compound are distributed among these MO's so that 16 occupy bonding, and 2 nonbonding MO's. This electron distribution permits an interpretation of the stability, the magnetic susceptibility and the absorption spectrum of ferrocene. A.

539.133

1819. Molecules of the insulin structure. D. Wrinch. *Science*, **116**, 562–4 (*Nov.* 21, 1952).

New cage structures for protein molecules are proposed which permit molecular models with as few as 48 skeletal residues to be built. The models provide sites for substituent residues and they can have the same or different numbers of residues with free α-amino groups and residues with free α-carboxyl groups and either of these numbers can be zero. For such structures molecular weights of the order of $48 \times 115 = 5520$ and upwards are to be expected. Applying these models to insulin they are seen to fit the experimental data with reasonable accuracy. Each of the 3 sub-units of insulin (102 residues) are analysed into two structures each with the necessary minimum of 48 residues. There are 24 references to earlier work and to the latest experimental work.

J. IBALL

539.133

1820. A modified Silberstein model of optical anisotropy. F. Matossi. *J. chem. Phys.*, **20**, 1934–5 (*Dec.*, 1952).

The Silberstein model of optical anisotropy is modified by the introduction of screening factors for the fields of the interacting induced dipoles. Thus, it is possible to apply the model consistently to molecular refraction, Rayleigh scattering, Raman effect, dipole moment, infrared intensities and Kerr effect. The numerical evaluation is carried out for O_2, N_2, Cl_2, CO_2 and CS_2. A.

539.133

1821. The molecular structure of arsine. H. H. Nielsen. *J. chem. Phys.*, **20**, 1955–6 (*Dec.*, 1952).

The method discussed by Nielsen for determining rotational term values for the vibration states ν_3 and ν_4 has been applied to the spectrum of AsH_3 and by this means the Coriolis factor $\zeta_4^{(z)}$ has been determined. The value of $\zeta_2^{(z)}$ was known from an earlier work as was the value $B^{(xx)}$. This permits the evaluation of $B^{(zz)}$ when use is made of the zeta sum rule for pyramidal XY_3 molecules, i.e. $\zeta_2^{(z)} + \zeta_4^{(z)} = (-1 + B^{(xx)}/2B^{(zz)})$. These constants lead to values for the AsH distance $r_0 = 1·523$ Å and for the H — As — H angle $\alpha = 91° 34'$. A.

539.133

1822. Determination of molecular structure from microwave spectroscopic data. J. Kraitchman. *Amer. J. Phys.*, **21**, 17–24 (*Jan.*, 1953).

A method is described for determining the position of an atom in a molecule from spectroscopic measurements on two isotopic species of the molecule. The method is applied to various types of molecules; explicit expressions are derived for linear, symmetric top, planar and nonplanar asymmetric top molecules. The number of isotopic species on which measurements must be made to complete the structural determination, i.e. determine the position of every atom in the molecule, is discussed for various types of molecules. An application of the method to the determination of mass difference ratios is also considered. A.

539.133

1823. Molecular compounds of the quinhydrone type. S. C. Wallwork and T. T. Harding. Letter in *Nature* [*London*] **171**, 40–1 (*Jan.* 3, 1953).

Gives the structure of phenoquinone as quinone molecules sandwiched between phenol molecules, with a hydrogen bond of 2·64 Å. Quinhydrone consists of alternating quinone and quinol molecules.

The cell dimensions of both are similar. It is suggested that this plane to plane stacking occurs in other quinones and aromatic nitrocompounds. C. TURNER

539.133

1824. The infrared spectra and the molecular structure of pyramidal molecules. H. H. NIELSEN. *J. chem. Phys.*, **21**, 142–4 (*Jan.*, 1953).

It is necessary to have explicit expressions for the rotational term values for the vibration states v_2 and v_4 in order to make use of the analysis of the data on the low frequency bands in the spectra of pyramidal XH_3 molecules. These frequencies are coupled by a Coriolis interaction which gives rise to a sub-matrix, for each value of J, in the complete energy matrix which has $3(2J + 1)$ rows and columns. These sub-matrices further break up into smaller ones which have at most three rows and columns. Explicit relations for the term values v_2 and v_4 require that these be diagonalized independently. It has been possible to expand the determinants of these sub-matrices in special cases where, for example, the quantum number $K = J$ and where $K = 0$ so that explicit relations for these states may readily be had. Using the frequency positions of lines involving transitions to these states permits the evaluation of the Coriolis factor $\zeta_4^{(z)}$. The structure of the molecules may also be fixed if then $B^{(xx)}$ and $\zeta_3^{(z)}$ can be determined, use being made of the zeta sum for XH_3 molecules, i.e. $\zeta_3^{(z)} + \zeta_4^{(z)} = -1 + B^{(xx)}/2B^{(zz)}$. A.

539.133 : 518.5

1825. Application of Eller's optical machine to the determination of the molecular structure of gases by electron diffraction. II. Nonrigid molecules. L. BRU, M. PEREZ RODRIGUEZ AND M. CUBERO. *J. chem. Phys.*, **20**, 1911–13 (*Dec.*, 1952).

For Pt I, see Abstr. 6685 (1952). The possibility is demonstrated of applying Eller's optical machine, as an auxiliary method of making calculations, to the study of the determination of the structure of gaseous molecules (nonrigid molecules) by means of the diffraction of electrons. The particular case of the $CF_3 - C \equiv CH$ is used as an illustration. A.

539.133

1826. The effect of hydrogen bonding on the hindered rotation of the hydroxyl group in alcohols. A. V. STUART AND G. B. B. M. SUTHERLAND. Letter in *J. chem. Phys.*, **20**, 1977 (*Dec.*, 1952).

The height of the potential barrier for hindered free rotation in gaseous CH_3OH corresponds to a normal frequency of 225 cm^{-1}. In the liquid state at concentrations for which hydrogen bonding takes place, the infrared spectrum reveals a broad band with maximum at 670 cm^{-1}. By deuteration of the OH group, the maximum is shifted to 475 cm^{-1}, which suggests a deformation vibration in which the H atom moves at right angles to the COH plane. This vibration is therefore identified with the rotation in the gaseous state, the higher frequency being accounted for by the increased force constant due to hydrogen bonding. At low concentrations, corresponding to negligible hydrogen bonding, the 670 cm^{-1} band disappears. H. H. GREENWOOD

539.133

1827. Proton magnetic resonance and molecular motion in solids. A. H. COOKE AND L. E. DRAIN. *Proc. Phys. Soc.* [*London*] *A*, **65**, 894–902 (*Nov.*, 1952).

Proton magnetic resonance widths and relaxation times have been measured in ammonium chloride, bromide and iodide, methyl alcohol and dimethyl sulphate from 90°K to 290°K. Line width transitions were observed in NH_4Cl and NH_4Br at 135°K and 99°K respectively. There were no sharp changes in either the relaxation time or line width at the temperatures of the λ-specific heat anomalies of the ammonium salts. Evidently, there is no marked increase in the rate of rotation of the ammonium ion at these transitions. The results for NH_4Br suggest that rotation of the NH_4^+ ion is hindered by a potential barrier of about 3500 cal/mole. The N–H distance is $1{\cdot}03 \pm 0{\cdot}01$ Å. The line width and relaxation time show pronounced changes at the λ-point of methyl alcohol, indicating a sudden change in the motion of the CH_3OH molecule. In solid dimethyl sulphate, a narrow line of small amplitude appears at about 170°K. A.

539.133

1828. Born repulsion and restricted free rotation. J. VAN DRANEN. Letter in *J. chem. Phys.*, **20**, 1982–3 (*Dec.*, 1952).

Calculations based mainly on the comparison of the charge distributions of He, the C–H bond, and H_2, and on data so far available, seem to show that there is some reason to attribute to the Born repulsion the major part (*c.* 1600 cal/mole) of the contribution to the potential barrier (*c.* 2750 cal/mole). F. LACHMAN

539.133

1829. Alkyl shifts in absorption spectra of azulene and other aromatic molecules. C. A. COULSON. *Proc. Phys. Soc.* [*London*] *A*, **65**, 933–45 (*Nov.*, 1952).

An inquiry is made into the factors which cause shifts in the ultra-violet spectra of aromatic molecules on substitution. The method of molecular orbitals is used, and the discussion is confined to π-electrons. It is shown that there are two chief effects: the first is essentially electrostatic, or inductive; the second is essentially conjugative, or mesomeric. In alternant hydrocarbons the second predominates and causes a red shift. In other molecules (e.g. azulene, quinoline) the first effect is considerably larger and now predominates over the second. Different positions of substitution will lead to shifts, sometimes to the red and sometimes to the blue. Electron donors will cause shifts in opposite directions to electron acceptors. The importance of these variations in characterizing the electronic transitions is stressed. Detailed investigation of the various methyl azulenes confirms the assignment of the long wavelength band with almost complete certainty. A.

539.133

1830. The excluded volume effect in polymer chains and the analogous random walk problem. R. J. RUBIN. *J. chem. Phys.*, **20**, 1940–5 (*Dec.*, 1952).

An excluded volume random walk is studied in an m-dimensional space. A general expression is obtained for the mean square length of a walk of N

eps, $\langle R_N^2 \rangle$. It is shown that the increase in $\langle R_N^2 \rangle$, , resulting from the interaction of only the ith and $+ s$th steps in the walk is a constant independent s in two dimensions. In three and four dimensions is of the order $s^{-\frac{1}{2}}$ and s^{-1} respectively. Thus, the teraction of the steps is surprisingly large. An timate is made of the upper bound on $\langle R_N^2 \rangle$ caused the simultaneous interaction of all steps. The sult in three dimensions is that in the limit of large , $\langle R_N^2 \rangle / N$ is at most of order $N^{\frac{1}{2}}$. A.

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

1831. Tables of nuclear shell structure. P. F. A. LINKENBERG. *Rev. mod. Phys.*, **24**, 63–73 (*April*, 952).

Table I, showing the odd mass nuclei, is divided ito two parts, referring respectively to odd proton nd odd neutron nuclei. For each, only the structure f the system of odd particles is given. The successive olumns of the table show: (1) number of neutrons; 2) number of protons; (3) chemical symbol; (4) mass umber, followed by an asterisk for radioactive uclei; (5) nuclear spin; (6) magnetic dipole moment; 7) electric quadrupole moment; (8) occupation of ne various shells; (9) ground state expected according o the model. Table II, referring to odd-odd nuclei, similar, except that the structures of both the roton and the neutron systems are given. The main eatures of the model and some anomalies are iscussed in the introduction. L. PINCHERLE

539.152.1

1832. On the binding energies of H^3 and He^4. . MORPURGO. *Nuovo Cimento*, **9**, 461–76 (*June*, 952) *In Italian.*

The mean value of the Hamiltonian is looked for ot among a class of functions containing some arameters, but among the whole class of the functions f an argument (which is assumed to be the sum of ne squares of the distances between the nucleons). Vith a Gaussian potential and central forces (with ne usual choice of parameters of Margenau) one btains in the first approximation −7·24 MeV for H^3 and −26·77 MeV for He^4. These values have to e compared with −7·21 MeV and −26·76 MeV btained by Margenau making use of a system of 4 and 11 variational functions. A refinement for H^3 lowers its energy to −7·79 MeV. Other advan- ages of the method are listed. A.

539.152.1

1833. Studies in *jj*-coupling. III. Nuclear energy evels. A. R. EDMONDS AND B. H. FLOWERS. *Proc. Roy. Soc. A*, **215**, 120–32 (*Nov.* 6, 1952).

For Pt II, see Abstr. 8993 (1952). The wave unctions for the configurations j^n, with $j = \frac{3}{2}, \frac{5}{2}$ nd $\frac{7}{2}$, obtained in Pt II of this series according to he particular scheme of Pt I, are here used to obtain ne central force energy matrices for nuclear con- gurations. The ordering of energy levels is studied s a function of the nature of the force with especial eference to its range, and the results are presented in the form of energy-level diagrams. The ordering of levels predicted to hold in Pts I and II when forces are of short range is shown to occur with practical ranges; but for light nuclei in particular it is demonstrated that levels of very high angular momentum may sometimes occur near to the ground state. The results are found to be largely independent of the precise nature of the forces provided they are of reasonably short range and are attractive in the ^1S state of two like particles; for definiteness, however, the diagrams have been drawn for a Rosenfeld symmetrical exchange force of Gaussian radial dependence. The effect of using other types of central interaction is discussed qualitatively. The lowest excited states of even-even nuclei are seen to have a simple interpretation in *jj*-coupling. A.

539.152.1

1834. Energy levels in light nuclei. J. S. ARTHUR, A. J. ALLEN, R. S. BENDER, H. J. HAUSMAN AND C. J. MCDOLE. *Phys. Rev.*, **88**, 1291–5 (*Dec.* 15, 1952).

Targets of beryllium, Nylon, lead fluoride, sulphur and lead sulphide were bombarded with 8 MeV protons from the University of Pittsburgh cyclotron. Energy levels were observed in Be^9, C^{12}, N^{14}, O^{16}, F^{19} and S^{32} by inelastic scattering at 150° from thin targets. Single levels were assigned in Be^9 and C^{12}; two levels were assigned in N^{14}; nine levels were assigned in F^{19}; and seven levels were assigned in S^{32}. A.

539.152.1

1835. Energy levels in magnesium, vanadium, chromium, and manganese. H. J. HAUSMAN, A. J. ALLEN, J. S. ARTHUR, R. S. BENDER AND C. J. MCDOLE. *Phys. Rev.*, **88**, 1296–9 (*Dec.* 15, 1952).

Targets of Mg, V, Cr and Mn have been bombarded by 8 MeV protons from the 47 in. cyclotron and the reaction particle observed at an angle of 150° to the incident beam. Three levels are assigned to Mg^{24}, seven to Mg^{25} and two to Mg^{26}. Fourteen levels are reported for V^{51}, 15 for Cr and 15 for Mn^{55}. A.

539.152.1 : 539.172.13

1836. Nuclear energy levels in the region of the 28-neutron shell. G. F. PIEPER. *Phys. Rev.*, **88**, 1299–1305 (*Dec.* 15, 1952).

Energy levels of the titanium nuclei of mass numbers 47, 48, 49, 50 and 51 have been obtained by measuring the ranges of proton groups from the reactions Ti(d, p)Ti. With the use of enriched isotopes, it has been possible to assign thirty observed Q values to their proper reactions. Good agreement was found in most cases in which results of this study could be compared with the results of others. The data have been analysed in terms of the strong spin-orbit coupling shell model of nuclear structure. A study of the binding energy of each residual nucleus and the energy of its first excited state revealed definite evidence for the existence of a closed shell at 28 neutrons. A.

539.152.1

1837. Nuclear structure and nuclear forces. V. F. WEISSKOPF. *Z. Phys.*, **133**, *No.* 1–2, 276–85 (1952).

A discussion of our present rudimentary knowledge in this field and in particular of the generalization to

complex nuclei of the facts ascertained from low-energy two-body effects. L. PINCHERLE

539.152.1

1838. Nuclei as compressible drops. II. Oscillations of the nuclear drops. K. WOESTE. *Z. Phys.*, **133**, *No.* 3, 370–93 (1952) *In German.*

For Pt I, see Abstr. 8995 (1952). The proper frequencies are calculated on a classical model, in Pt A for a compressible drop starting from the equations of motion and in Pt B for an incompressible drop from conservation of energy. Results are summarized in a table. This gives, for atomic weights 100, 172 and 238, the excitation energy of oscillations of various order for compressible and incompressible, charged and uncharged drops, and also for the proton-neutron oscillations of an incompressible charged nucleus. Some terms are present only in the compressible case, for which the frequencies are smaller, corresponding, for $l = 2$, to a decrease of 2 in the value of Z at which spontaneous fission occurs. L. PINCHERLE

539.152.1

1839. The interaction of alpha-particles and the binding energy of ^{8}Be. S. F. EDWARDS. *Proc. Cambridge Phil. Soc.*, **48**, *Pt IV*, 652–64 (1952).

A calculation of the binding energy of Be^8 is given, based upon the separation of the 8 nucleons into 2 groups of 4, using Gaussian functions and a Yukawa central force. The calculation is considerably simplified by the use of an integral identity between the Gaussian potential and the Yukawa potential. The energy is calculated with a Gaussian potential, and the identity used to convert the result to that which would have been obtained by direct use of the Yukawa potential. The results of the variational calculation show that unless the saturation conditions usually adopted in the theory of heavy nuclei are abandoned, there can be no binding, confirming an earlier result of Margenau, obtained with a Gaussian potential. The results do not depend essentially on the range of the force, nor on the central two-body type of force adopted. When the old saturation conditions are abandoned, quite reasonable results are obtained. The magnitude of the energies due to the exchange of single particles and pairs of particles indicates that the force between α-particles is not additive. A discussion of the saturation conditions and of the α-particle model in the light of the results is given. A.

539.152.2

1840. The determination of nuclear moments from radiospectra. G. J. BÉNÉ. *J. Phys. Radium*, **13**, 473–9 (*Oct.*, 1952).

A review. The theory is summarized and the main methods, excluding the resonance ones, are described. L. PINCHERLE

539.152.2

1841. The alignment of cobalt 58. J. M. DANIELS, M. A. GRACE, H. HALBAN, N. KURTI AND F. N. H. ROBINSON. *Phil. Mag.*, **43**, 1297–300 (*Dec.*, 1952).

The technique for obtaining alined Co nuclei has been applied to the isotope Co^{58}. An examination of the angular distribution of the 0·805 MeV γ-ray shows that this transition cannot be dipole but is probably quadrupole. The temperature dependence of this angular distribution gives for the nuclear magnetic moment a value of $3{\cdot}5 \pm 0{\cdot}3$ nuclear magnetons. This result is discussed in relation to the nuclear shell-model. A.

539.152.2

1842. Magnetic moments and quadrupole moments of odd-mass nuclei in *jj*-coupling. B. H. FLOWERS. *Phil. Mag.*, **43**, 1330–4 (*Dec.*, 1952).

Magnetic moments and quadrupole moments of nuclei are treated in a model which considers all particles outside the core of completed levels on an equal footing. It is shown that in this way better agreement with experimental magnetic moments is obtained than from the simpler Schmidt model. The manner in which electric quadrupole moments arise in odd-neutron nuclei without the assumption of a deformable core is also discussed. A.

539.152.2

1843. Relativistic corrections to magnetic moments of nuclear particles. G. BREIT AND R. M. THALER. Letter in *Phys. Rev.*, **88**, 1214–15 (*Dec.* 1, 1952).

539.152.2

1844. A nuclear resonance modulation correction. M. M. PERLMAN AND M. BLOOM. *Phys. Rev.*, **88**, 1290–1 (*Dec.* 15, 1952).

A theoretical modulation correction with experimental justification is derived. It is found that the experimentally measured value of the second moment is always larger than the true value by an amount $\frac{1}{3}H_m^2$ where H_m is the modulation amplitude. The correction holds even for amplitudes close to the line width and gives consistently good results when applied to the analysis of line shapes. A.

539.152.2 : 548.7

1845. Second-order effects in nuclear electric quadrupole interaction of Al^{27} in spodumene. H. E. PETCH, G. M. VOLKOFF AND N. G. CRANNA. Letter in *Phys. Rev.*, **88**, 1201–2 (*Dec.* 1, 1952).

The authors' previous generalization to non-uniaxial crystals of Pound's original work [Abstr. 8401 (1952)] has been extended to terms of the second order in the quadrupole coupling constant and checked on the example of the Al^{27} resonance in $LiAl(SiO_3)_2$. L. PINCHERLE

539.153

1846. The spatial correlation of electrons in atoms and molecules. II. Two-electron systems in excited states. A. BRICKSTOCK AND J. A. POPLE. *Phil. Mag.*, **43**, 1090–8 (*Oct.*, 1952).

For Pt I, see Abstr. 6702 (1952). Extends the treatment of the ground state of He and similar two-electron systems, given in Pt I, to excited states which are not spherically symmetric. The wave function is expanded in a series of surface harmonics, the coefficients being functions of the radial distances. Symmetry considerations and the angular momentum operators are used to simplify the problem, and a set of coupled equations for the radial functions are then given. This general theory is exact. In the final section it is used to discuss the effect of the exclusion principle on angular correlation in atomic *P*-states and is applied to excited states of Be. A.

539.153

847. Fine structure of the hydrogen atom. V. T. Triebwasser, E. S. Dayhoff and W. E. Lamb, Jr. *Phys. Rev.*, **89**, 98–106 (*Jan.* 1, 1953).

For Pt IV, see Abstr. 6704 (1952). Improvements in apparatus and techniques of measurement of the $2^2S_{\frac{1}{2}} - 2^2P_{\frac{1}{2}}$ level shifts in H and D are described. The more accurate results are $\delta_H = 1057{\cdot}77 \pm 0{\cdot}10$ Mc/s and $\delta_D = 1059{\cdot}00 \pm 0{\cdot}10$ Mc/s. These values are compared with results of quantum electrodynamic calculations. The shape of the resonance curves has been examined in great detail and compared with theory. Assuming the theoretical value of the radiative width and hyperfine splittings, excellent agreement is obtained. Further, if only the radiative width is assumed, measurements on H reported here confirm theoretical hyperfine splittings to within 0·28 Mc/s. Since contributions of the hyperfine structure of the 2*S* level have been measured to far greater accuracy, these results constitute a confirmation of the 2*P* hyperfine splittings to an accuracy of 1·0%. A.

539.153

848. Fine structure of the hydrogen atom. VI. J. S. Dayhoff, S. Triebwasser and W. E. Lamb, Jr. *Phys. Rev.*, **89**, 106–15 (*Jan.* 1, 1953).

Measurements of improved accuracy of transition frequencies from the $2^2S_{\frac{1}{2}}(m = +\frac{1}{2})$ state to several of the $2^2P_{\frac{3}{2}}$ magnetic sub-states in D are presented and analysed. The shape of the observed resonance curves is discussed and compared with theory. The experimental result is given for the $2^2P_{\frac{3}{2}} - 2^2S_{\frac{1}{2}}$ separation, $\Delta E_D - \delta_D = 9912{\cdot}59 \pm 0{\cdot}10$ Mc/s, for D. This is combined with the result for δ_D reported in the preceding abstract to obtain the $2^2P_{\frac{3}{2}} - 2^2P_{\frac{1}{2}}$ separation, $\Delta E_D = 10\,971{\cdot}59 \pm 0{\cdot}20$ Mc/s for D. From ΔE_D and the auxiliary constants R_D and c a new value is computed for the fine structure constant $\alpha = 1/(137{\cdot}0365 \pm 0{\cdot}0012)$. The uncertainty stated is considered to be a limit of error for the experimental procedure without allowance for the uncertainty of the auxiliary constants. A.

539.153

849. The Lamb shift for hydrogen and deuterium. E. E. Salpeter. *Phys. Rev.*, **89**, 92–7 (*Jan.* 1, 1953).

Previous calculations of all 2nd and 4th order radiative corrections, which contribute to the Lamb shift, are discussed. Further corrections to the Lamb shift in H and D, resulting from the finite mass and internal structure of the nuclei, are calculated. The final theoretical results for the Lamb shift, excluding all 6th order corrections, are $(1057{\cdot}19 \pm 0{\cdot}16)$ Mc/s for H and $(1058{\cdot}49 \pm 0{\cdot}16)$ Mc/s for D. These values are about half a megacycle smaller than the corresponding experimental results. A.

539.153 : 535.337

Effect of an electric field on the probe of the H I ($2P_0 - n^2D$) lines emitted in radiative transitions. *See Abstr.* 1495

539.153 : 537.561

1850. The stopping power of *K*-electrons. M. C. Walske. *Phys. Rev.*, **88**, 1283–9 (*Dec.* 15, 1952).

The stopping power of *K*-shell electrons for large incident particle energies is calculated, adding to and correcting previous work on the subject. A definition is given for the average ionization potential of an atom independent of the energy of the incident particle. An integral representation is derived for Bethe's term C_K which corrects the simple *K*-shell stopping number expression. Finally, asymptotic formulae, applicable at large incident particle energies, are given for use with any element. A.

539.153 : 539.172

1851. Atomic electron ejection in large-angle scattering. M. E. Ebel and W. F. Fry. *Phys. Rev.*, **88**, 1306–8 (*Dec.* 15, 1952).

It is found that an electron in the keV range frequently accompanies the large-angle scattering of μ-mesons, π-mesons and protons in photographic emulsions. For μ-mesons of energy between 1·6 and 4·1 MeV which are scattered through angles greater than 28°, there is observed an electron of energy greater than 10 keV in $21 \pm 6\%$ of the scatterings. The electron energy distribution seems to follow an inverse 7/2 power law. These electrons are interpreted as being ejected as the result of the direct Coulomb action of the incident particle on the electrons of the scattering atom. The high probability of ejection arises from the fact that an incident particle which undergoes a large-angle scattering always passes through the region of greatest electron density. The probability of ejection is calculated from second-order perturbation theory using approximations valid at high energies. Although the approximations limit the usefulness of the result, the assumed mechanism seems adequate for the description of the phenomenon. A.

539.153.4

1852. An analytical method for the approximate determination of the eigenfunctions and energies of electrons in atoms. R. Gáspár. *J. chem. Phys.*, **20**, 1863–5 (*Dec.*, 1952).

The first section shows that the reduced effective nuclear charges Z_p/Z, determined without exchange by the "self-consistent field" method, can be approximated by a universal function, if the distance from the nucleus is measured in the unit of length $\mu = 0{\cdot}8853a_0/Z^{\frac{1}{3}}$, which changes from atom to atom. This universal function can also be approximated by a simple analytical expression. One of the possible applications of the above result is to use it to determine good starting potentials for calculations to be carried out by the "self-consistent field" method. The universal effective nuclear charge, especially in its analytical form, also allows the determination of important atomic constants for each element of the periodic system. The second section solves the one-electron Schrödinger equation by Rasetti's method, developing it to determine analytically the eigenfunctions and energies of electrons in the deepest *s*, *p*, *d* and *f* energy states. The X-ray terms obtained by this method and the experimental ones are in good agreement with each other and with those calculated by the "self-consistent field" method. A.

539.153.4

1853. Wave functions and energy levels for Cu^+ as found by the Slater approximation to the Hartree–Fock equations. G. W. Pratt, Jr. *Phys. Rev.*, **88**, 1217–24 (*Dec.* 15, 1952).

Results of a self-consistent field calculation

using the Slater method are given for Cu^+. Wave functions, energies, total radial charge density, $2(2l+1).(1-Z_{nl})$ functions for the $3p$ and $3d$ electrons and the $2Z_p(r)$ functions are listed. The corresponding results for the Hartree–Fock method, and in some cases the Hartree method, are given for comparison of the various calculations. The method of integrating the radial wave equation and a method for shortening the self-consistent calculation are included. A.

539.155.2

1854. Measurement of the deuterium concentration of water condensed from a Larderello borax spring. E. Cerrai, C. Marchetti and M. Silvestri. *Nuovo Cimento*, **9**, 511–17 (*June*, 1952) *In Italian.*

A float method was used. In order to increase precision, the sample was previously enriched in an electrolytic cell, whose separation factor had been controlled by Milan tap water, before and after the enrichment of the Larderello sample. Assuming the concentration of the former as 0·015%, the Larderello water vapour concentration is 0·0149 ± 0·0006%. A.

539.155.2

1855. Application of a float method to rapid D_2O concentration measurement in heavy water aqueous solutions. E. Cerrai, C. Marchetti and M. Silvestri. Note in *Nuovo Cimento*, **9**, 530–4 (*June*, 1952) *In Italian.*

The method is suitable for water samples of low D_2O content (a few mole percent). It needs no calibration with samples of known D_2O content. A.

539.155.2 : 550.93

Variations in the relative abundances of the isotopes of common lead. *See Abstr.* 2093

539.155.4

1856. Mass of K^{40}. W. H. Johnson, Jr. Letter in *Phys. Rev.*, **88**, 1213 (*Dec.* 1, 1952).

The mass doublets Ca^{40}–A^{40} and K^{40}–A^{40} were obtained by comparison with $(C^{12})_2O^{16}$ (from acetic acid) using a double focusing mass spectrometer, as 0·021 ± 0·015 and 1·595 ± 0·071 milli-mass units; the total energies for the decay of K^{40} to Ca^{40} and A^{40} are 1·30 ± 0·07 and 1·49 ± 0·07 MeV resp.

A. O. Stanesby

539.155.4

1857. Masses of light atoms. K. Ogata and H. Matsuda. *Phys. Rev.*, **89**, 27–32 (*Jan.* 1, 1953).

The mass differences of 33 doublets have been measured with a modified Bainbridge–Jordan type mass spectrograph, which has an experimental resolving power of about 60 000. In general, the values obtained are in good agreement with other mass spectroscopic data and with those calculated from nuclear disintegration energies. However, for the $C^{12}(H^1)_4 - O^{16}$ doublet, the discrepancy between the present value 364·19 ± 0·06 ($\times 10^{-4}$ a.m.u.) and the value 363·72 ± 0·19 obtained from nuclear data does not seem to be neglible. The author calculated the atomic mass of C^{12}, one of the mass substandards from the four different doublet sets, one with the $C^{12}(H^1)_4 - O^{16}$ doublet and the others without. The four values of the C^{12} mass obtained were found to be in good agreement with one another, and their weighted average, 12·003844 ± 6, was adopted as the atomic mass of C^{12}. Other mass substandards H^1 and D^2 were calculated from the $(H^1)_2 - D^2$ doublet and the $(D^2)_3 - \frac{1}{2}C^{12}$ doublet using the above C^{12} mass, and the atomic masses of H^1 and D^2 were obtained to be $H^1 = 1{\cdot}008145 \pm 2$, $D^2 = 2{\cdot}014741 \pm 3$. The atomic masses of other isotopes were determined by using these mass substandards. A.

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

1858. The absolute measurement of high-energy radiation. B. M. Spicer. *Austral. J. sci. Res. A*, **5**, 581–91 (*Dec.*, 1952).

The relationship between incident intensity of X-rays and the ionization produced by them in a small cavity behind an aluminium wall of given thickness has been derived, and calculations performed for a specific case. The conditions of validity of Gray's relation are the only ones imposed. The calculation was performed for monoenergetic radiation, and extended to the case of a bremsstrahlung spectrum of the form given by Schiff (Adams 1948). Comparison is made with the work of Fowler, Lauritsen, and Lauritsen (1948) and Lawson (1950). A.

539.16.08 : 778.33

1859. Study of radioactive minerals by combined electron-reflection radiography and autoradiography. J.-J. Trillat and L. Tertian. *C.R. Acad. Sci. [Paris]* **235**, 1123–5 (*Nov.* 10, 1952) *In French.*

The distribution of regions of different chemical constitution is shown by electron radiography and the radioactivity of these regions is shown by autoradiography. Examples are given of the application of the technique to pitchblende of different origins.

J. Thewlis

539.162

1860. On the evaporative theory of nuclear disintegrations. F. Ferrari and C. Villi. *Nuovo Cimento*, **9**, 487–504 (*June*, 1952) *In Italian.*

The Fermi gas model has been extended to high nuclear temperatures according to a mathematical procedure independent of the restrictive condition $r/\psi \ll 1$. The modification of the momentum distribution brought about by the nuclear interactions has been considered qualitatively of the same kind as that due to thermal agitation. Calculations have been carried out on the basis of the "nuclear equivalent temperature" τ at which the nucleon gas, having a true temperature T, may be considered as an ideal one. The relation between true and equivalent temperature has been assumed of the form $\tau = T + a\psi(\tau)$, where $a = 0{\cdot}29$ is the Watanabe parameter and $\psi(\tau)$ is the Fermi function characteristic for highly degenerate gases. On the basis of the curve of total excitation energy versus true nuclear temperature T, and following Weisskopf's theory, the evaporation process, initiated by a nucleus of energy E_0, has been studied stage by stage, taking into account the diminution of the nuclear temperature

nd the variation of the atomic mass number. It has een found that the nuclear energy losses can be well epresented by a third order difference relation. The nergy summation formula thus derived leads to a ourth degree equation, the solution of which gives he total number of particles evaporated from a ucleus of initial energy E_0. On evaluating the ratio (E_0) between the number of charged particles and he total number $N(E_0)$ of them as a function of the xcitation energy of the residual nucleus, an expression s obtained for the number of ionizing particles vaporated from a nucleus of energy E_0. Fluctuations ave been calculated with the Poisson formula. It s possible to determine the energy lost in the evapora- ion process, which is found to be 110–120 MeV. A.

539.162

1861. The application of the recoil in nuclear processes. L. MEITNER. *Z. Phys.*, **133**, *No.* 1–2, 40–52 (1952) *In German.*

A review of experiments using recoils in α, β and γ-emissions: early demonstrations of α-recoils; discussion of attempts to study the neutrino by β-recoils; the Szilard–Chalmers process.

W. J. SWIATECKI

539.162 : 536.166

1862. Dependence of gamma-radiation lifetimes on nucleon configurations. R. D. HILL. Letter in *Phys. Rev.*, **88**, 1428 (*Dec.* 15, 1952).

Widely varying discrepancies between experimental and theoretical $E3$ lifetimes show a regular dependence on nucleon configuration complexity. J. J. WILKINS

539.163

1863. Relation between the radioactive properties of nuclei and the chemical structure of the molecules which enclose them. R. DAUDEL. *J. Phys. Radium*, **13**, 557–62 (*Nov.*, 1952) *In French.*

Three cases had been predicted theoretically in which a variation of the nuclear radioactive period should be discernible: (i) electron capture, (ii) internal conversion, (iii) β-emission. For (i) and (ii) this variation has been observed; further lines of inquiry are suggested. J. JACOBS

539.163 : 539.164

1864. Spontaneous fission *versus* alpha-decay. A. KRAMISH. Letter in *Phys. Rev.*, **88**, 1201 (*Dec.* 1, 1952).

By plotting the ratio R (spontaneous fission $\frac{1}{2}$-life/α-disintegration $\frac{1}{2}$-life) against the fissionability parameter Z^2/A, it is shown that for even-even nuclei, the spontaneous fission made of decay becomes the more predominant as Z^2/A increases; the opposite appears to be true for odd-neutron nuclides.

A. O. STANESBY

539.163.1

1865. The half-life of ThC′. T. HAYASHI, Y. ISHIZAKI AND I. KUMABE. *J. Phys. Soc. Japan*, **8**, 110–12 (*Jan.–Feb.*, 1953).

The accurate measurement of the half-life of ThC′ was made by the pulse timing circuit method using a G.M. counter and a proportional counter. The value of the half-life was found to be $(2{\cdot}9 \pm 0{\cdot}1) \times 10^{-7}$ sec. Some details of the pulse timing circuit used are explained in this paper. A.

539.163.2

1866. On the disintegration scheme of K^{40}. M. PAGANELLI AND G. QUARENI. *Nuovo Cimento*, **9**, 324–35 (*April*, 1952) *In Italian.*

Evidence is presented to confirm the association between K-capture and γ-emission. Using the counter arrangement described, the coincidences between γ-radiation and the products of K-capture, namely Auger electrons and X-rays, are detected. A.

539.163.2

1867. The natural radioactivity of rubidium. G. M. LEWIS. *Phil. Mag.*, **43**, 1070–4 (*Oct.*, 1952).

The radioactive decay of Rb^{87} has been studied using the scintillations from a crystal of rubidium iodide activated with thallium, some fluorescent properties of which are described. This method, free from source absorption and scattering troubles, indicates a β-spectrum with an end point of 275 KeV. The Fermi plot gave a forbidden shape, for the most part close to that given by recent proportional counter work using 2π geometry, but having slightly more counts at the high-energy end, and fewer at the low-energy end; the half-life has been determined at $(5{\cdot}90 \pm 0{\cdot}3) \times 10^{10}$ years. The theoretical interpretations are indicated. A.

539.163.2

1868. Radioactive gold isotopes. F. D. S. BUTEMENT AND R. SHILLITO. *Proc. Phys. Soc.* [*London*] *A*, **65**, 945–9 (*Nov.*, 1952).

The half-lives, mass assignments and radiation characteristics of three neutron-excess gold isotopes have been determined as follows:

	Au^{200}	Au^{201}	Au^{203}
Half-life	48 min	26 min	55 sec
Max. β-energy (MeV)	2·2	1·5	1·9
γ-energy (MeV)	0·39, 1·13	0·55	0·69

A.

539.163.2

1869. The disintegration scheme of V^{48}. P. L. ROGGENKAMP, C. H. PRUETT AND R. G. WILKINSON. *Phys. Rev.*, **88**, 1262–5 (*Dec.* 15, 1952).

The disintegration scheme involved in the decay of 16 day V^{48} to Ti^{48} has been established by scintillation studies, and spins and parities have been assigned to the levels. The angular correlation of the well-known cascade γ-ray pair with energies of 0·99 and 1·32 MeV has been measured. The corresponding levels are found to have spins 0–2–4. The positron spectrum has been measured with a magnetic β-ray spectrometer and shows evidence for positron emission to a level in Ti^{48}, 22·2 MeV above the ground state. The positron group involved in the decay to the 2·31 MeV level of Ti^{48} is found to have an end point of 0·69 MeV. A.

539.163.2

1870. Disintegration scheme of Fe^{59}. F. R. METZGER. *Phys. Rev.*, **88**, 1360–7 (*Dec.* 15, 1952).

The radiations accompanying the disintegration of Fe^{59} have been investigated using lens spectrometer and scintillation counter techniques. Three β-ray spectra of end points 1560 ± 8 keV (0·3%), 462 ± 3 keV (53·9%) and 271 ± 3 keV (45·8%) lead to the ground state, to 1098 keV and 1289 keV excited

states of Co^{59}. The 1560 keV spectrum has a forbidden shape; the shapes of the other partial spectra are allowed. γ-rays of 191 ± 2 keV (2·8%), 1098 ± 6 keV (56·7%) and 1289 ± 6 keV (43%) represent all the transitions possible between the three Co^{59} states. The conversion coefficients characterize the 191 keV and the 1098 keV transitions as magnetic dipoles, the 1289 keV transition as electric quadrupole. A disintegration scheme is presented in which spins and parities are assigned to all the levels involved. The single-particle orbitals corresponding to the assigned spins and parities agree with those of the spin-orbit coupling shell model. Accordingly, the first excited state (1098 keV) of Co^{59} is an $f_{5/2}$ state, and its 1098 keV energy difference from the $f_{7/2}$ ground state represents the spin-orbit splitting of the f-levels, which is responsible for the existence of a closed shell at N or $Z = 28$. The angular correlation of the 191 keV–1098 keV γ–γ cascade was measured and found to support the proposed spin assignment. A.

539.163.2

1871. The nuclides Ba^{127}, Ba^{128}, and Cs^{128}. M. Lindner and R. N. Osborne. Letter in *Phys. Rev.*, **88**, 1422 (*Dec.* 15, 1952).

Study of the Ba and Cs fractions after irradiation of a Cs nitrate target with 190 MeV deuterons gave: Ba^{127}, $\frac{1}{2}$-life 12 min, probably β^+-emitter; Ba^{128}, principally electron capture; Cs^{128}, $\frac{1}{2}$-life 3.80 min, ~25% electron capture. A. O. STANESBY

539.163.2

1872. The disintegration energy of Ti^{51}. L. Koester, H. Maier-Leibnitz, T. Mayer-Kuckuk, K. Schmeiser and G. Schulze-Pillot. *Z. Phys.*, **133**, *No.* 1–2, 319–24 (1952) *In German.*

The β- and γ-spectra of Ti^{51} were investigated, using absorption, β-spectrometer, γ-scintillation-counter and coincidence measurements. The β-spectrum is complex with $E_{max} = 2{\cdot}2 \pm 0{\cdot}1$ MeV; there is a γ-ray of 0·32 MeV, which is not in coincidence with the highest energy partial β-spectrum. The disintegration energy is in agreement with the shell-model discussions of Suess and Jensen [Abstr. 2931 (1952)]. A. O. STANESBY

539.163.2

1873. Characteristics of Br^{87}, a delayed neutron activity. A. F. Stehney and N. Sugarman. *Phys. Rev.*, **89**, 194–203 (*Jan.* 1, 1953).

The energies of the β-rays of Br^{87} were determined to be 2·6 and 8·0 MeV by Al absorption measurements. Gamma-radiation was observed, and from the absorption curve of the secondary Compton electrons, the maximum energy of the γ-radiation was found to be 5·4 MeV. Most of the γ-rays have energies in the range 2 to 4 MeV. Coincidences were observed between the weaker β-ray and the γ-rays. γ–γ coincidences were also noted. The fission yield of Br^{87} was found to be 3·1%. A.

539.164

1874. On the rôle of the atomic electrons in α-emission. P. Benoist-Gueutal. Letter in *J. Phys. Radium*, **13**, 486–7 (*Oct.*, 1952) *In French.*

See also abstract following. It is shown that for known α-emitters the rearrangement of the atomic electrons during α-emission must be regarded as a "slow" perturbation of the atom, so that the available Coulomb energy is given up to the α-particle, and does not lead to excitation of the residual atom. For many β-emitters, the perturbation is "sudden," and self-ionization of the residual atom may be expected. A. O. STANESBY

539.164

1875. On the excitation of atomic electrons during the α-disintegration of polonium 210. M. Riou. Letter in *J. Phys. Radium*, **13**, 487–8 (*Oct.*, 1952) *In French.*

The author's earlier suggestions [Abstr. 7526 (1952)] that the Pb *K*- and *L*-X-rays detected in Po^{210} were due respectively to emission following internal conversion of the 800 keV γ-radiation, and to excitation of impurity Pb atoms by the α-particles are shown to be untenable, and an alternative explanation in terms of two direct processes, internal ionization and self-ionization (negligible for Po^{210}, see preceding abstract) is provided. The agreement for internal ionization is satisfactory, and means of confirmation are suggested. A. O. STANESBY

539.164

1876. Systematics of alpha ray spectra. M. L. Chaudhury. *Z. Phys.*, **133**, *No.* 5, 561–75 (1952).

The Geiger–Nuttal relation in α-radioactivity postulates a positive trend in the variation of disintegration constant λ with α-energy E. A number of energy groups within the different α-ray spectra deviate from the above linear relation and have been designated as anomalous in some recent works. The present study shows that this anomaly is only apparent and there exists some regularity in the variation of λ with energy E of the spectral components. Instead of the positive gradient of the Geiger–Nuttal relation, the new systematics for the α-ray spectra give both positive and negative trends in the $\log \lambda$ *v.* E-relation. It will also be observed that for highly complex spectra the positive and the negative trends follow one another regularly, with one or two exceptions. These negative gradients do not agree with the α-decay theories of Gamow and of others, and the discrepancy factor, $\lambda_{theoretical}/\lambda_{observed}$, is shown to be in general of the order of 10^3 while in some cases it exceeds 10^{13}. The theoretical implications of the new systematics have been qualitatively studied and a possible way of explaining the above disagreement is indicated. Besides, another important correlation, viz. the Fournier curves for α-decay energy *v.* mass number, has been reconsidered in the light of α-ray spectra, and it is found that interesting suggestion can be made about the possible existence of subshells at neutron numbers 128 and 134. Alternative speculation of some weak components in the α-spectra of Po^{213}, Bi^{213} and Ra^{224} is less probable. A.

539.164

1877. Alpha-radioactivity in the 82-neutron region. J. O. Rasmussen, Jr, S. G. Thompson and A. Ghiorso. *Phys. Rev.*, **89**, 33–48 (*Jan.* 1, 1953).

In a survey for α-activity among cyclotron-produced neutron-deficient nuclides of the elements below Pb, α-activity was detected in a number of rare earth nuclides with atomic number greater than 62, that of Sm, and in a Au and a Hg nuclide. A detailed study

the α-active nuclides of Eu, Gd, Tb and Dy was ade. The relationship between α-decay rates and ergies in the rare earth region is examined. Cal- lations of the "effective nuclear radius for α- rticles" were made using 5 different α-decay rate rmulae. The trends of the rare earth α-decay ergies are discussed, particularly with respect to e discontinuity in neutron binding energies at the osed shell of 82 neutrons. A.

539.164 : 539.166

178. The alpha-gamma angular correlation in diothorium. J. Battey, L. Madansky and F. Asetti. *Phys. Rev.*, **89**, 182–5 (*Jan.* 1, 1953).

The α-decay of radiothorium is followed by an ·3 keV γ-ray whose angular correlation with the particle was investigated, using scintillation counters nd fast coincidence circuits. The correlation curve oes not agree with any of the theoretical ones derived nder the assumption that the angular momenta of e three states involved are $0 - J - 0$. Possible asons for this somewhat unexpected result are scussed. A.

539.165/.166

379. The beta-decay of F^{20}. D. E. Alburger. *hys. Rev.*, **88**, 1257–61 (*Dec.* 15, 1952).

The β-decay of F^{10} has been investigated with lens spectrometer using sources activated by the $^{19}(d, p)F^{20}$ reaction. A simple β-ray spectrum of lowed shape is observed having an end-point energy f 5·406 ± 0·017 MeV. Beta-emission is followed by 1·631 ± 0·006 MeV γ-ray from an excited state of Ne^{20}. The γ-ray energy was checked by comparing ith the Sb^{124} γ-ray, measured as 1·692 ± 0·005 MeV nd by failure to observe photoneutrons from Be. eta-ray branching to the ground state of Ne^{20}, if resent, has a relative intensity of less than 1%. The otal F^{20} disintegration energy, 7·038 ± 0·018 MeV, used together with other nuclear data to derive a Ne^{20} mass which is independent of mass spectrographic easurements. The result, $Ne^{20} = 19·998794 \pm$ ·000026 a.m.u., is in agreement with mass spectro- raphic values. A.

539.165/.166

880. Nuclear spectra of Rb^{82} and Rb^{84}. C. M. Huddleston and A. C. G. Mitchell. *Phys. Rev.*, 8, 1350–4 (*Dec.* 15, 1952).

The nuclear spectra of Rb^{82} (6·3 hr) and Rb^{84} 34 days) have been measured with a magnetic lens pectrometer. Rb^{82} emits two positron groups of nergies 0·775 and 0·175 MeV. It also decays by rbital electron capture. A large number of γ-rays ccompanies the disintegration. Reasonable agree- ent with the γ-rays emitted by Br^{82} has been btained. Rb^{84} emits three groups of positrons having nd-point energies of 1·629, 0·822 and 0·373 MeV. ne γ-ray whose energy is 0·890 MeV has been ound. Level diagrams for these disintegrations are iscussed. A.

539.165/.166

881. The radiations of Th^{231}(UY). M. S. Freed- an, A. H. Jaffey, F. Wagner, Jr and J. May. *hys. Rev.*, **89**, 302–9 (*Jan.* 1, 1953).

Beta-ray spectrum studies on a double-lens spectro- eter of the electron spectrum of UY revealed a complex spectrum with three β-components of 302 keV (44%), 216 keV (11%) and 94 keV (45%), and numerous conversion lines assignable to γ's of 22, 59, 63, 85, 122, 167 and 208 keV, each of these except the 122 keV also observed directly as γ's in a scintillation spectrometer. There is also evidence for a 107 and for a 230 keV γ-ray. The samples were separated carrier-free from isotopically pure U^{235} (99·86%) by solvent extraction. A decay scheme is presented which gives a total disintegration energy of 324 keV. A.

539.165

1882. An experimental investigation of the stability of nuclei against double beta-disintegration. J. H. Fremlin and M. C. Walters. *Proc. Phys. Soc.* [*London*] *A*, **65**, 911–15 (*Nov.*, 1952).

Samples containing elements of even Z have been examined for possible β-activity using a photographic emulsion technique. For the elements Cr. Fe, Ni, Zn, Ge and Cd the results show that the effective half-value period for double β-decay for the elements as a whole is in each case greater than 10^{17} years if the disintegration energy is 2 MeV or more (or greater than 10^{16} years if the disintegration energy is 0·35 MeV or more). For Ca, Mo, Sr. Sn, Te, Ba, W, Os and Pt lower limits between 2×10^{14} and 6×10^{16} years are similarly obtained on the assumption of 2 MeV disintegration energy, the residual uncertainty in most cases being due to the slight contamination of the samples with natural radio-elements. A possible weak β-activity shown by samples containing Mo requires further examination. A.

539.165

1883. The beta-decay of the triton. J. M. Blatt. *Phys. Rev.*, **89**, 86–92 (*Jan.* 1, 1953).

A general formula is derived for the β-decay matrix elements in the decay of a nucleus into its mirror nucleus. This formula is specialized to the decay of H^3. Under the assumption of charge independence of nuclear forces, it is shown that the value $(\int\sigma)^2 = 3$ computed on the basis of a pure $^2S_{\frac{1}{2}}$ ground state is an upper limit for the true value of this matrix element, provided only that the $^2S_{\frac{1}{2}}$ state is present with a probability of at least 25%. A.

539.165 : 539.166

1884. The beta-gamma angular correlation of ^{170}thulium. H. Rose. *Phil. Mag.*, **43**, 1146–50 (*Nov.*, 1952).

A thin magnetic lens β-ray spectrometer has been modified to enable the β–γ angular correlation of Tm^{170} to be measured as a function of β-ray energy. Assuming that a single matrix element is operative in the low energy β-ray transition of Tm^{170}, the results give a good agreement with the theoretical predictions for the matrix element $\int\beta\sigma\times r$ occurring in the first forbidden tensor interaction but appear to rule out the corresponding $\int\sigma\times r$ of the first forbidden axial vector interaction. It is, however, possible that a suitable mixture of matrix elements might also fit the experimental data. A.

539.165 : 539.166

1885. On interference effects in angular correlation. O. Hittmair. *Acta phys. Austriaca*, **6**, *No.* 1, 71–7 (1952) *In German.*

The interference of different multipoles in angular

correlation is discussed on a general group-theoretical basis; the correction factor for the energy-spectrum of a β-emitter is easily obtained. The β–γ correlation of K^{42} and Rb^{86} is discussed. A. O. STANESBY

539.165.08

1886. The dosimetry of β-rays from radioactive isotopes in homogeneous substances. K. SOMMERMEYER. *Z. Phys.*, **133**, *No.* 1–2, 201–8 (1952) *In German.*

It is shown that it is necessary to know the specific ionization, or the range of the β-ray in the medium containing the radioactive isotope. A simple generally applicable method for the solution of this problem is given, and illustrated by application to a special case. Further, a simple method for the determination of the activity of a radioactive solution is given. J. HUGHES

539.165.2

1887. The effect of a finite nucleus on beta-decay. I. MALCOLM. *Phil. Mag.*, **43**, 1011–27 (*Oct.*, 1952).

Relativistic wave functions are derived for the electron in a potential field which is constant within the nucleus and Coulombian outside. The relative values of the cut-off wave-functions and the pure Coulomb wave-functions are calculated both for the discrete and continuous spectrum. The changes thereby produced in the probability of orbital electron-capture, in the continuous β-spectrum and in the ratio of probabilities of K-capture to positron emission are examined. It is concluded that for the heavier nuclei the probability of K-capture and the ratio of the probabilities of K-capture to positron emission are appreciably affected. The modifications produced in the continuous spectrum are greatest for spin change equal to n where $n(n > 1)$ is the degree of forbiddenness of the transition. In this case the coefficients of the squares and products of matrix elements given in the correction factors of Konopinski and Uhlenbeck are appreciably changed. Therefore for given values of the matrix elements the spectrum is modified. A.

539.165.2

1888. The evidence of the once-forbidden spectra for the law of β-decay. H. M. MAHMOUD AND E. J. KONOPINSKI. *Phys. Rev.*, **88**, 1266–75 (*Dec.* 15, 1952).

A series of empirical arguments has developed which leave two alternatives for the law of β-interaction: an *STP* (scalar + tensor pseudoscalar) or a *VTP* ($V \equiv$ vector) combination. A new argument is offered, based on an interpretation of the reported "allowed" shapes of once-forbidden spectra, which favours the *STP* over the *VTP* form. This new development may be important because it is a possible last step in arriving at a unique law of β-decay (i.e. all three components of the *STP* form would become both admissible and necessary). A critical stage in the new argument is the explanation of the "allowed" shapes. The theory may yield such shapes if the Coulomb potential energy at the nucleus is sufficiently larger than the kinetic energy with which electron and neutrino are emitted. That condition happens to be best fulfilled just for the cases in which the "allowed" shapes are the most accurately observed. However, the dominance of the Coulomb effect cannot be a sufficient condition except with the *STP* or *VA* forms of β-interaction. Other forms make deviations from the allowed shape possible even when the Coulomb energy is supposed indefinitely large. The last type of deviation has the same origin as the well-known Fierz interference in allowed spectra. The absence of the latter effect has been widely quoted but apparently never heretofore examined in detail. It is important in one of the series of arguments mentioned above. Hence, we investigate the empirical limits on Fierz-type deviations not only in once-forbidden but also in allowed spectra. A.

539.165.2

1889. Meson theory of β-decay and the ΔL-forbidden transitions. S. NAKAMURA. *Phys. Rev.*, **89**, 16–19 (*Jan.* 1, 1953).

Existence of the β-meson of vector type which is neither a π- nor μ-meson and which transmits the β-decay of nuclei has been tentatively assumed, the results thus derived being compared with experiments on β-decay. The differences between the β-meson theory and the phenomenological Fermi theory lie in the natural deduction of the vector interaction as well as the introduction of new nuclear matrix elements which are characteristic of the meson dipole. The selection rules for the ΔL-forbidden transitions are involved in these matrix elements, the orders of which are expected to be that of the unfavoured parity transitions in each degree of forbidden transitions. The observability of a free β-meson is also discussed. A.

539.165.2

1890. The beta-decay interaction. J. M. BLATT. *Phys. Rev.*, **89**, 83–5 (*Jan.* 1, 1953).

The recent identifications of two β-decays as 0-to-0 transitions proves that the β-decay interaction must contain a component obeying Fermi selection rules. Evidence is presented regarding the relative strengths of the Fermi– and Gamow–Teller interactions, and experiments are suggested to improve knowledge of these strengths. It is pointed out that the He^6 *ft*-value does not give significant information about the β-decay interaction. An experiment is proposed to determine the nature (scalar or polar vector) of the Fermi interaction. A.

539.165.8

1891. The average electric charge of daughter atoms from β-decay and isomeric transition. S. WEXLER AND T. H. DAVIES. Letter in *Phys. Rev.*, **88**, 1203–4 (*Dec.* 1, 1952).

This was determined by measuring the ion current in a low pressure ionization chamber filled with calibrated sources of $(H^3)_2$, $C^{14}O_2$, a mixture of Kr and Xe fission products, and $C_2H_5Br^{80m}$, with the following results: H^3, $\sim +1$; $C^{14} \sim +1$; fission gases $\sim +1{\cdot}3$; $Br^{80m} \sim +10$ electronic charges. A. O. STANESBY

539.165.8

1892. Atomic excitation in beta-decay. H. M. SCHWARTZ. *J. chem. Phys.*, **21**, 45–51 (*Jan.*, 1953).

The excitation and ionization of the daughter atom coming from a β-decay, which is of interest in connection with some hot atom studies and possibly also in connection with β-recoil experiments, is the subject of an introductory discussion with explicit calculations

given only in the case of one-electron hydrogen-like wave function representation of atomic states. The latter correct results in the literature, the only ones so far published on this subject. The present discussion is confined to direct effects of the β-process itself and does not evaluate those resulting from Auger processes. A.

539.166

1893. Further measurements on the γ rays produced by neutron capture in beryllium and carbon. G. A. Bartholomew and B. B. Kinsey. *Canad. J. Phys.*, **31**, 49–54 (*Jan.*, 1953).

New measurements have been made of the neutron capture radiation from Be and C using a more sensitive pair spectrometer. From Be, γ-rays with energies of 6·81 and 3·41 ± 0·06 MeV were detected. The former is the ground state γ-ray previously reported [Abstr. 4575 (1952)]. The 3·41 MeV γ-ray, which has an intensity of about 0·25 photon per capture, seems to be due to the excitation of the first excited state in Be^{10}. From C, in addition to the 4·95 MeV ground state γ-ray previously reported, a γ-ray was found with an energy of 3·68 ± 0·05 MeV and with an intensity of about 0·3 photon per capture. No γ-rays were observed which could be associated with the excitation of the level at 3·9 MeV in C^{13}. A.

539.166.08

1894. Precision measurements of the gamma-radiation from scandium^{46}. T. Lindqvist. *Ark. Fys.*, **6**, *Paper* 13, 123–6 (1952).

Measurements made with a double-focusing β-spectrometer indicated γ-rays of 0·885 ± 0·002 and 1·119 ± 0·002 MeV. Details of the adjustment and calibration of the spectrometer are given.

J. J. WILKINS

539.166.08 : 541.15

Chemical dosimetry of gamma rays in the presence of slow neutrons. *See Abstr.* 2025

539.166.79

1895. Polarization of the O^{16} gamma-rays. L. W. Fagg and S. S. Hanna. Letter in *Phys. Rev.*, **88**, 1205–6 (*Dec.* 1, 1952).

The 6·13, 6·9 and 7·1 MeV γ-rays were produced by the $F^{19}(p, \alpha)$ reaction and detected at 90° by D_2O loaded nuclear plates. The observed partial polarizations are discussed in terms of parity assignments.

J. J. WILKINS

539.166.79

1896. Polarized γ-rays from nuclei aligned at low temperatures. G. R. Bishop, J. M. Daniels, G. Goldschmidt, H. Halban, N. Kurti and F. N. H. Robinson. Letter in *Phys. Rev.*, **88**, 1432 (*Dec.* 15, 1952).

Partial polarization of γ-rays from aligned Co^{60} and Co^{58} nuclei has been demonstrated by a Compton scattering method. All three γ-transitions are electric quadrupole. J. J. WILKINS

539.166.83

1897. A study of the γ-transitions of Ra (188 keV) and of RdTh (87 keV). C. Victor, J. Teillac, P. Falk-Vairant and G. Bouissières. *J. Phys. Radium*, **13**, 565–6 (*Nov.*, 1952) *In French.*

The internal conversion coeffs. were determined from coincidence (α-particle/conversion-electron) and α-particle fine-structure measurements, and confirm the γ-radiations as electric quadrupole. A. O. Stanesby

539.166.83

1898. The Auger effect. E. H. S. Burhop. *London, Cambridge University Press*, 188 + xiv *pp.*

Review in *Brit. J. appl. Phys.*, **3**, 397 (Dec., 1952).

539.166.835

1899. Proposal for a lens type pair spectrometer. M. S. Freedman. Letter in *Rev. sci. Instrum.*, **23**, 643–4 (*Nov.*, 1952).

It is possible to convert a lens spectrometer for use as a pair spectrometer without loss in either transmission or resolution by replacing the detector by a thick crystal scintillation counter in the normal axial position. Only those pulses corresponding to twice the energy being focused by the magnetic field are counted as pairs. G. D. SIMS

539.166.835

1900. Pair measurement of gamma-rays with a lens spectrometer. D. E. Alburger. *Rev. sci. Instrum.*, **23**, 671–7 (*Dec.*, 1952).

A conventional lens spectrometer has been adapted to the measurement of high-energy γ-rays by detecting positron-electron pairs in coincidence. The source and converter are centred on the optic axis and the baffle system selects pairs of nearly equal energy. The detection method consists of dividing the focal circle of confusion in half and observing coincidences between particles entering these two regions. Statistically the components strike different areas in half the cases. The detectors are semicircular anthracene crystals connected by light pipes to 1P21 photomultiplier tubes. Pulses from these are fed through amplifiers to a coincidence circuit of 7×10^{-8} sec resolving time. The method has been tested by observing "pair peaks" due to the 2·76 and 2·62 MeV γ-rays of Na^{24} and ThC″ respectively. The Po–Be reaction γ-ray has been measured at 7·5% resolution and found to have an energy of 4·47 ± 0·04 MeV. Using a proton beam from the Brookhaven electrostatic accelerator γ-rays of 6·19 ± 0·08 MeV and 7·13 ± 0·12 MeV occurring in the $F^{19}(p, \alpha)O^{16}$ reaction have been observed with this apparatus. The results on both Po–Be and the fluorine reaction are in agreement with previous measurements by other methods. A.

539.169

1901. Methods of working with the radioactive sulphur isotope ^{35}S. L. v. Erichsen and R. Müller. *Angew. Chem.*, **64**, *No.* 21, 580–5 (1952) *In German.*

A detailed description of the preparation, properties and possible uses of this isotope whose half-life of 88 days and the soft β-radiation make it valuable for various investigations in the fields of inorganic chemistry, organic chemistry and biochemistry. The method of handling S^{35}-containing substances is also described. Methods of isolating the active sulphate and of measuring its activity are described, since the directly obtained numbers of impulses do not lend themselves to direct activity comparisons. The relative activities used for the accurate sulphur balance sheets are discussed. F. LACHMAN

539.169 : 778.33

Autoradiography of metal surfaces using a radiochemical method. *See Abstr.* 2128

NUCLEAR REACTIONS 539.17

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 1730–6

539.172

1902. Excitation of nuclear dipole oscillations by fast electrons. F. SCHLÖGL. *Z. Phys.*, **133**, *No.* 4, 485–98 (1952) *In German.*

Theoretical. These oscillations may be described as oscillations of the proton density relative to the neutron density. The nucleus is treated as a spherically symmetrical harmonic oscillator. The interaction is assumed to be purely electromagnetic and treated by a perturbation method of the Born type. The number of inelastically scattered electrons depends strongly on direction and the nuclear oscillations occur prevalently in directions perpendicular to that of the incident electrons. L. PINCHERLE

539.172.11/.13

1903. Barrier penetration effects for light nuclei. B. E. FREEMAN AND J. L. MCHALE. *Phys. Rev.*, **89**, 223–6 (*Jan.* 1, 1953).

The penetration parameters F_L^2/ρ, ρ/G_L^2 and ρ/A_L^2 have been compared as functions of energy for a number of reactions induced by proton or α-particle bombardment of light nuclei. It was found that these parameters behaved quite similarly in the energy range considered, particularly for $L > 0$. The limitations on the applicability of barrier "penetration factors" in the treatment of reaction cross-sections are investigated by computing a number of typical cases, making use of the one-body model with allowance for absorption of the incident wave. Several sets of values of nuclear radius and well depth were used. The relation between the one-body cross-section without absorption and the channel penetration parameters, f_L^2/ρ and ρ/g_L^2, is treated in some detail for the $Li^7(p, \alpha)\alpha$ reaction. Breit's consideration of the case of very strong absorption $\sigma_L \propto 1/A_L^2$, is also presented. The connection between the one-body model without absorption and a one-level dispersion formula in the vicinity of sharp resonance is used to tabulate the properties of a number of one-body resonances. In a number of cases resonances were found to be broadened markedly by the absorption of the incident wave in nuclear matter. A.

539.172.13

1904. Electron capture. I. Resonance capture from hydrogen atoms by fast protons. D. R. BATES AND A. DALGARNO. *Proc. Phys. Soc.* [*London*] *A*, **65**, 919–25 (*Nov.*, 1952).

Born's approximation is used to calculate the cross-section associated with resonance charge exchange between protons and hydrogen atoms, it being pointed out that in earlier treatments of this problem unjustified simplifying assumptions were made. An energy range of up to 250 keV is covered. The predicted energy variation of the cross-section is in harmony with the results of Ribe's recent laboratory work on collisions of protons with hydrogen molecules. A.

539.172.13

1905. Interference between Coulomb and nuclear scattering in *p-p* collisions at 240 MeV. H. P. NOYES AND H. G. CAMNITZ. Letter in *Phys. Rev.*, **88**, 1206–7 (*Dec.* 1, 1952).

This effect is insufficient to remove the forward peak predicted by the Christian–Noyes tensor potential or to alter qualitatively the predictions of the Jastrow model. It is shown, however, that the latter is extremely sensitive to relativistic effects.

W. J. SWIATECKI

539.172.13

1906. Physical analysis of Be and C disintegration induced by 330-MeV protons. W. H. BARKAS AND H. TYREN. *Phys. Rev.*, **89**, 1–3 (*Jan.* 1, 1953).

The disintegration products of C and Be emerging from thin targets bombarded by an internal cyclotron beam of 330 MeV protons have been studied. The magnetic field of the cyclotron is employed for momentum analysis and nuclear track plates for detection and range analysis. On plotting radius of curvature *v.* range, various nuclear species are found to fall on identifiable loci. The relative abundances of the products and their momentum spectra are obtained. H, He, Li and B products have been found and their abundances tabulated. Alpha-particles prove to be the most important charged particle product. Be yields significantly more T than C. Some of the heavy products are found with very high momenta. A.

539.172.13

1907. Angular distribution of gamma-rays and short-range alpha-particles from $N^{15}(p, \alpha\gamma)C^{12}$. A. A. KRAUS, JR, A. P. FRENCH, W. A. FOWLER AND C. C. LAURITSEN. *Phys. Rev.*, **89**, 299–301 (*Jan.* 1, 1953).

Measurements of these angular distributions indicate that the 4·432 MeV excited state of C^{12} is 2^+ or >4, that the 12·51 MeV level of O^{16} is 2^- or >5, that the 12·95 MeV level is 2^- or >5, and that the 13·24 MeV level is 4^+ or >5. A.

539.172.13 : 539.18

1908. Production of charged π-mesons in H, D, C, Cu, and Pb by 381-MeV protons. M. M. BLOCK, S. PASSMAN AND W. W. HAVENS, JR. *Phys. Rev.*, **88**, 1239–47 (*Dec.* 15, 1952).

The differential cross-section for the production of charged π-mesons at 90° from a 381 MeV proton beam has been measured in H, D, C, Cu and Pb. Nuclear emulsions, embedded in a tapered Cu absorber, placed 90° below the internal circulating proton beam of the Nevis cyclotron detected mesons of both signs, from 0 to 125 MeV. The beam was monitored by means of the C^{11} activity produced in the target to determine the absolute cross-section. The H and D results were obtained by subtracting the C cross-section from polyethylene and deuterated paraffin, respectively. Assuming the reaction in H is $p + p \rightarrow \pi^+ + d$ with a $\cos^2\theta$ angular distribution, the total cross-section for H at 381 MeV is calculated from the 90° value to be $(7{\cdot}3 \pm 2{\cdot}3) \times 10^{-28}$ cm². The spectra for heavy nuclei are calculated with the

assumptions that meson production occurs through nucleon-nucleon collisions and that the meson receives the maximum available energy in the c.m. system. Good agreement with the experimental results is found for matrix elements proportional to meson momentum. The π^+ production cross-section increases with a dependence slower than $A^{\frac{1}{3}}$, whereas the π^- increases approximately as $A^{\frac{2}{3}}$. This asymmetry is also found in the large π^+/π^- ratio of 10 in C and about 25 in D. A.

539.172.13 : 539.18

1909. Excitation function for charged π-meson production in hydrogen and carbon by 345- to 380-MeV protons. S. Passman, M. M. Block and W. W. Havens, Jr. *Phys. Rev.*, **88**, 1247–53 (*Dec.* 15, 1952).

The 90° differential cross-section for charged meson production in H and C is measured for incident proton energies 345 to 380 MeV. For H, the 90° π^+ meson production energy spectra occur as peaks in the energy region predicted from the kinematics of the reaction $p + p \rightarrow \pi^+ + d$. Ratios of these 90° π^+ differential cross-sections are $(d\sigma)/(d\omega)$ at 380 MeV: $(d\sigma)/(d\omega)$ at 365 MeV: $(d\sigma)/(d\omega)$ at 345 MeV $= 2{\cdot}6 : 1{\cdot}6 : 1$ with a statistical uncertainty of 15%. For C the π^+ meson production spectra show an increase in the energy of the maximum of the broad distributions, with increasing incident proton energy. The $(\pi^+)/(\pi^-)$ ratio in C is found to be in the range $(10 \pm 3) : 1$ for all 3 proton energies studies. Qualitative agreement with these C π^+ meson spectra is obtained from a phenomenological analysis based upon the assumptions of nucleon-nucleon collisions in which the target has a Gaussian momentum distribution. A.

539.172.13

1910. The theory of (*d*, *t*) reactions. H. C. Newns. *Proc. Phys. Soc.* [*London*] *A*, **65**, 916–19 (*Nov.*, 1952).

Expressions for the angular distribution of tritons emitted from nuclei bombarded with deuterons have been obtained using Born's approximation and the non-perturbation method of Butler. Discussion of the effect of different forms of the triton wave function on the angular distribution is given. The theory is shown to explain the experimental angular distributions satisfactorily.

539.172.13

1911. Angular distribution of neutrons from the *d*-*d* reaction. P. Baker, Jr and A. Waltner. Letter in *Phys. Rev.*, **88**, 1213–14 (*Dec.* 1, 1952).

50 keV incident deuterons were used and the neutrons were observed with nuclear plates at 7 angles to the beam. Results were in agreement with those of other methods. The asymmetry coefficient A was measured as $0{\cdot}25 \pm 0{\cdot}05$. F. R. HOLT

539.172.13

1912. The reaction energies of $Ne^{21}(d, \alpha)F^{19}$ and $Ne^{21}(d, p)Ne^{22}$ from magnetic analysis. C. Mileikowsky and W. Whaling. *Phys. Rev.*, **88**, 1254–7 (*Dec.* 15, 1952).

Separated isotopic targets of Ne^{21}, which were produced at the Nobel Institute of Physics, have been used to measure the Q-values of the reactions (1) $Ne^{21}(d, \alpha)F^{19}$, and (2) $Ne^{21}(d, p)Ne^{22}$. A double focusing magnetic spectrograph was used to compare the energy of the protons and α-particles from these reactions with the α-particles from ThC and ThC′. The angle of observation and the deuteron bombarding energy were chosen so that the particles being studied and the α-line used for energy calibration lay nearly side by side on the photographic plate used as a detector. The Q-values measured are $6{\cdot}432 \pm 0{\cdot}010$ MeV for reaction (1) and $8{\cdot}137 \pm 0{\cdot}011$ MeV for reaction (2). From these Q-values and the mass of F^{19} the atomic masses of Ne^{21} and Ne^{22} are obtained. Other α-groups from reaction (1) correspond to transitions to states in F^{19} at $0{\cdot}113 \pm 0{\cdot}008$ MeV and $0{\cdot}192 \pm 0{\cdot}012$ MeV above the ground state. Additional particle groups from N and Na contamination on the targets have been observed: the Q-values measured are $8{\cdot}613 \pm 0{\cdot}011$ MeV for $N^{14}(d, p)N^{15}$ and $4{\cdot}723 \pm 0{\cdot}008$ for $Na^{23}(d, p)Na^{24}$. A.

539.172.13

1913. Angular distribution of the neutrons from the reaction $^7Li(d, n)^8Be$. B. Trumpy, T. Grotdal and A. Graue. Letter in *Nature* [*London*] **170**, 1118–19 (*Dec.* 27, 1952).

The neutron energy spectrum (determined from recoil proton tracks) resulting from bombardment with 680 keV d, reveals levels at 5·0, 4·1, 2·9, (2·2) MeV in Be^8. The angular distributions show no forward peaks. W. J. SWIATECKI

539.172.13

1914. Magnetic analysis of the $F^{19}(d, p)F^{20}$ and $F^{19}(d, \alpha)O^{17}$ reactions. H. A. Watson and W. W. Buechner. *Phys. Rev.*, **88**, 1324–31 (*Dec.* 15, 1952).

The energy spectrum of protons from the $F^{19}(d, p)F^{20}$ reaction has been analysed at 90 degrees to the incident deuteron beam, using an annular magnetic spectrograph with photographic detection. Nineteen proton groups have been observed and identified with this reaction. These correspond to the ground state of F^{20} and eighteen excited states in the range of excitation from 0 to 5·1 MeV. Deuteron bombarding energies ranging from 1·5 to 2·1 MeV were used. Tracks of α-particles, arising from the $F^{19}(d, \alpha)O^{17}$ reaction, were also observed on the photographic plates. Alpha-particle groups corresponding to the ground state and ten excited levels of O^{17} in the range of excitation from 0 to 6·9 MeV were identified. Some of the groups corresponding to O^{17} levels of sufficient excitation to be unstable against neutron decay exhibited a broadening which may result from the natural width of the corresponding O^{17} levels. A.

539.172.3

1915. Limit on repulsive core from 100-MeV deuteron photoeffect. N. Austern. Letter in *Phys. Rev.*, **88**, 1207–8 (*Dec.* 1, 1952).

Calculations of the effect of a repulsive core nuclear potential on the photoelectric cross-section are reported. Comparison with available experimental data is sufficient only to indicate a core radius $< 0{\cdot}8 \times 10^{-13}$ cm. J. J. WILKINS

539.172.3 : 539.18

1916. Production of π^0-mesons by γ-rays on hydrogen. A. Silverman and M. Stearns. *Phys. Rev.*, **88**, 1225–30 (*Dec.* 15, 1952).

The production of π^0 mesons in the reaction $\gamma + p \rightarrow \pi^0 + p$ is investigated as a function of the incident γ-ray energy in the region from 200 MeV to

300 MeV. For the π^0 emitted at approximately 90° laboratory angle, the differential cross-section can be represented by $(d\sigma_{\pi^0}/d\Omega)_{\pi/2} = C(K - 145)^{1\cdot9\pm0\cdot4}$, where K = energy of incident γ-ray in MeV. The approximate threshold for the reaction is 145 MeV. The ratio of the cross-section at 60° laboratory angle to that at 90° laboratory angle, for γ-rays between 250 MeV and 300 MeV, is $1\cdot45 \pm 0\cdot25$. A.

539.172.3 : 539.18

1917. Production of π^0-mesons in hydrogen and deuterium by high energy γ-rays. G. Cocconi and A. Silverman. *Phys. Rev.*, **88**, 1230–3 (*Dec.* 15, 1952).

The angular distribution of the π^0's and the dependence of the cross-sections on the energy of the γ-rays have been studied for the reactions $\gamma + P \rightarrow \pi^0 + P$, $\gamma + P \rightarrow \pi^0 + D(P, N)$. For the first reaction, the angular distribution in the centre-of-mass system has the form $a + b \sin^2 \bar{\theta}$, with $a/b \simeq 1$, and the cross-section is proportional to approximately the square of the excess energy of the γ-rays above the threshold; $\sigma_D/\sigma_H \simeq 2$ at all energies and angles. A.

539.172.4

1918. The inelastic scattering of fast neutrons. M. J. Poole. *Phil. Mag.*, **43**, 1060–9 (*Oct.*, 1952).

An anthracene scintillation counter has been used as a spectrometer to measure the energy distribution of initially monokinetic neutrons scattered from Fe and Al. In each case discrete groups of neutrons with reduced energy were found, showing that the scattering nucleus was being raised to its excited states. The differential cross-section for scattering through 97° has been measured for the various processes. A.

539.172.4

1919. The total neutron cross-sections of cobalt, silver, iodine, aluminium, nickel and gallium between 1 eV and 5 keV. A. W. Merrison and E. R. Wiblin. *Proc. Roy. Soc. A*, **215**, 278–89 (*Nov.* 25, 1952).

The main interest of the measurements lies in the use of improved resolution at the higher energies with the result that certain levels have now been more clearly resolved. The results are presented as curves showing the variation of total cross-section with neutron energy. For certain levels, the strength of the resonance is calculated. The spectrometer is briefly described and some reference made to previous work in the same field. A.

539.172.4

1920. Activation cross sections for 14-MeV neutrons. S. G. Forbes. *Phys. Rev.*, **88**, 1309–11 (*Dec.* 15, 1952).

Cross-sections for several nuclear reactions induced by 14 MeV neutrons were measured by the activation method. The number of activated atoms was determined by absolute β-counting. Corrections for finite sample thicknesses were determined experimentally in every case. Cross-sections for the following reactions were measured: $(n, 2n)$ for Cu^{63}, Cu^{65}, Ag^{107} and Ag^{109}; (n, p) for Al^{27}, P^{31}, Fe^{56} and Cu^{65}; (n, α) for Al^{27}. A.

539.172.4

1921. Total neutron cross section of sodium. P. H. Stelson and W. M. Preston. *Phys. Rev.*, **88**, 1354–7 (*Dec.* 15, 1952).

The total neutron cross-section of Na has been measured over the energy range 120 to 1000 keV using resolutions of 2·5 to 5 keV. A number of resonances, corresponding to excited states in the compound nucleus Na^{24} were investigated. In some cases it is possible to assign J and l values and to compute the effective level spacings D_J^l. Evidence is given to show that the D_J^l, which are a measure of the complexity of a state, differ by a factor of 8 for two states of the same type and at approximately the same excitation energy (7·5 MeV) in the Na^{24} nucleus. An anomalous S-wave resonance at 300 keV suggests that the potential scattering may be spin dependent. A.

539.172.4

1922. Formation of He^6 by 14-MeV neutron bombardment of Li and Be. M. E. Battat and F. L. Ribe. *Phys. Rev.*, **89**, 80–3 (*Jan.* 1, 1953).

Formations of He^6 by bombardment of Li^6, Li^7 and Be^9 with 14 MeV neutrons has been observed. The He^6 was identified by its known half-life and the decay rate observed on a ten-channel time-delay analyser. Beta-rays from the He^6 were detected by means of a thin-walled proportional counter, and the over-all counting efficiency was determined by using the $Cu^{63}(n, 2n)Cu^{62}$ reaction. Cross-sections determined for the $Li^6(n, p)$, $Li^7(n, d)$ and $Be^9(n, \alpha)$ reactions were $6\cdot7 \pm 0\cdot8$, $9\cdot8 \pm 1\cdot1$ and 10 ± 1 millibarns, respectively. The half-life of He^6 was found to be $0\cdot83 \pm 0\cdot03$ sec. A.

539.172.4

1923. The total *n-p* scattering cross section at 4.75 MeV. E. M. Hafner, W. F. Hornyak, C. E. Falk, G. Snow and T. Coor. *Phys. Rev.*, **89**, 204–22 (*Jan.* 1, 1953).

Attenuation measurements in good geometry on polyethylene and graphite scatterers with transmissions from 0·30 to 0·65 have been made. A thin-walled gas target was used, producing forward *d-d* neutrons at a mean energy of $4\cdot749 \pm 0\cdot009$ MeV. Care was taken to minimize uncertainties arising from neutrons of other energies, from unshadowed background, and from impurities in the samples. The geometry was such that multiple scattering-in contributed no more than 0·12% to the total uncertainty. Checks against rate-dependent sensitivity of the detector revealed no effects greater than 0·15%. The total *n-p* scattering cross-section deduced from the measurements is $1\cdot690 \pm 0\cdot006_6$ barns, where the probable error has been increased from the statistical error of $0\cdot002_4$ barn to include the energy uncertainty and estimates of possible systematic effects. Values of $r_{0s}^{(n-p)}$, the singlet effective range of the *n-p* interaction, obtained from this result for several potential shapes, are compared with corresponding values of $r_{0s}^{(p-p)}$. The validity of the hypothesis of charge independence is found to depend on the potential shape assumed. A.

539.172.4

1924. Activation energy for fission. G. T. Seaborg. Letter in *Phys. Rev.*, **88**, 1429 (*Dec.* 15, 1952).

The recently noticed correlation between spontaneous fission rates and Z^2/A is used to estimate the barrier height against fission for 30 nuclides (Ra^{226} to Cm^{242}). Coupled with data on neutron binding

nergies this leads to predictions as to the occurrence f slow neutron fission which are verified without ception. W. J. SWIATECKI

539.172.4 : 621—52 : 621.039.42

925. Automatic control characteristics of thermal eutron reactors. J. H. BOWEN. *Instn Elect. Engrs aper* 1432, 8 *pp.* (1952).

The influence of the phenomenon of "delayed" eutrons on the problem of automatically controlling ne power level of a thermal nuclear reactor is escribed. The frequency-response characteristic of a eactor is obtained theoretically and shown to be onfirmed experimentally; from it is derived an mpirical transfer function. It is shown that the bserved response of the closed-sequence system con- olling reactor power, following step changes in the esired power level, agrees well with the response alculated from this transfer function. Some practical ses of the analysis are indicated. A.

539.172.4 : 621.039.42 : 621—5

926. The control of a thermal neutron reactor. . V. MOORE. *Instn Elect. Engrs Paper* 1431, 12 *pp.* 1952).

The nuclear and thermal characteristics of a gas- ooled graphite-moderated reactor, as they affect he control of such plants, are described, and general rinciples of design are formulated. Interpretation f these principles in terms of main control elements ollows, and examples of mechanisms and circuits nvolved are given. The special operating phases f starting up and shutting down unique to nuclear lants are analysed separately. Emphasis is laid on afety, rendered important by the radioactive nature f the heat source and the exponential nature of uclear power changes. In addition to the provision f properly designed safety devices, it is urged that he biggest safeguards come from a full understanding f the reactor transient and steady-state characteristics nd their careful exploitation in the control-system esign. A.

539.172.4 : 778.34

927. Energy loss of highly charged particles pro- uced by fission and by cosmic rays. I. Observations f fission fragments. P. DEMERS. *Canad. J. Phys.*, **31**, 8–96 (*Jan.*, 1953).

Measurements on the range of the tracks of fission ragments recorded in special laboratory-made emul- ions are reported. The origin was marked so that bservations on length not possible otherwise were nade. Stopping power and struggling for such tracks n different media are discussed. It is shown that the ange of one fragment is little dependent on the range f the other paired fragment. The blackening of he two tracks near the origin is on the average nequal, that of the light fragment L being darker. t is inferred that ionization is greater near the origin or the L fragment. Knock-on protons allow a range elocity curve to be drawn, and evidence is advanced o prove that the light associated particles are indeed nock-on protons. A.

539.172.4 : 778.34

928. Energy loss of highly charged particles pro- uced by fission and by cosmic rays. II. Photometric easurements on fission fragments. R. MATHIEU AND P. DEMERS. *Canad. J. Phys.*, **31**, 97–111 (*Jan.*, 1953).

A sensitive and accurate photometer is described, which is designed to measure directly the light intensity transmitted through very small objects placed under the microscope at the highest resolving powers. Tracks of mesons, protons, α-rays and fission fragments were examined with it, characteristic curves relating optical density D and ionizing power I were obtained and show the feature, unusual for light sensitivity, of two sensitive regions separated by a region of very low gamma. The variation of optical density and of width with ionizing power is discussed for three types of emulsion. Measurements on fission tracks are analysed to derive a single range ionization relation $I = 1{\cdot}22 + 0{\cdot}738\,R$, in MeV and microns, applicable to both heavy and light fragments, in agreement with Section I. The controversial literature on this matter is discussed. A.

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

1929. On the production of $\varkappa$-mesons. U. HABER-SCHAIM AND G. YEKUTIELI. Letter in *Phil. Mag.*, **43**, 997–8 (*Sept.*, 1952).

The numbers of κ's and π's produced in nuclear collisions in the range 20–1000Mc^2 are calculated using Fermi's theory and assuming (*a*) 2 different Yukawa particles (*b*) only a pion field. The observed high relative yields of κ ($n_\kappa/n_\pi \sim 0{\cdot}6$ at 50 BeV) favours (*b*). W. J. SWIATECKI

539.18

1930. The mean lifetime and frequency of production of charged V-particles. K. H. BARKER, C. C. BUTLER, M. G. SOWERBY AND C. M. YORK. *Phil. Mag.*, **43**, 1201–9 (*Nov.*, 1952).

Data for the determination of the mean lifetime of charged V-particles are discussed, following the procedure outlined by Wilson and Butler (1952). The tracks of twenty-seven $V\pm$-particles have now been photographed on the Pic-du-Midi (2867 m) by Armenteros *et al.* (1952) and by the authors in a circular cloud chamber, 28 cm in diameter. It is shown that, using these data, the chamber is too small for the lifetime to be determined, but a lower limit of $1{\cdot}0\times10^{-10}$ sec is obtained. Furthermore, the relation between the frequency of production of energetic $V\pm$-particles in penetrating showers of average energy (10–30) BeV, and various assumed lifetimes is discussed. Using recent photographic emulsion data on the frequency of particles of mass about 1200 m_e in the same type of penetrating shower an upper limit for the lifetime of 10^{-8} sec is obtained. A.

539.18

1931. On the decay of charged V-particles. J. P. ASTBURY, P. CHIPPINDALE, D. D. MILLAR, J. A. NEWTH, D. I. PAGE, A. RYTZ AND A. B. SAHIAR. *Phil. Mag.*, **43**, 1283–90 (*Dec.*, 1952).

Among 18 000 photographs taken during an experiment with a large cloud chamber at the

Jungfraujoch (3580 m) 13 examples of the decay of charged V-particles have been observed. A summary of the measurements of the 13 particles is given. Two of them are produced in nuclear interactions of remarkably low energy. The average time that the particles would have taken to cross the chamber, if they had not decayed in flight, is $\sim 10^{-9}$ sec, and the distribution of the decay events does not differ significantly from that which would be expected for particles with a mean life greater than 10^{-9} sec. A.

539.18

1932. τ-Meson decay in flight. M. Annis and N. F. Harmon. Letter in *Phys. Rev.*, **88**, 1202–3 (*Dec.* 1, 1952).

A photograph of a cloud chamber containing 11 Pb plates taken under 680 g cm^{-2} can be interpreted as the decay of a 1100 ± 310 MeV τ into 3 π's of 490 ± 170, 400 ± 140, 300 ± 110 MeV. W. J. SWIATECKI

539.18

1933. The S wave in pion-nucleon scattering. R. E. Marshak. Letter in *Phys. Rev.*, **88**, 1208 (*Dec.* 1, 1952).

The deduced S phase shifts for the $\frac{3}{2}$ isotopic spin state (± 25, ± 15, $\pm 5{\cdot}8°$ at 135, 110, 78 MeV resp.) can be reproduced by assuming an effective attractive potential (sq. well or exponential) with an ∞ repulsive core. W. J. SWIATECKI

539.18

1934. Charge independence and multiple pion production. L. Van Hove, R. Marshak and A. Pais. Letter in *Phys. Rev.*, **88**, 1211 (*Dec.* 1, 1952).

A new type of relation between the differential cross-sections for meson production in nucleon-nucleon collisions, implied by the charge independence hypothesis, is given. The generalization of this and other relations to multiple meson production is indicated, an example for double meson production being discussed. R. H. DALITZ

539.18

1935. Coulomb effects in pion scattering by protons under the charge independence hypothesis. L. Van Hove. *Phys. Rev.*, **88**, 1358–60 (*Dec.* 15, 1952).

The differential cross-sections for scattering of charged π-mesons by protons, observed so far at energies and angles for which Coulomb effects are negligible, were found compatible with the assumption of charge independence for the nuclear interaction between pion and nucleon. For the future discussion of scattering experiments now being performed at lower energies, the Coulomb effects are calculated, retaining the charge independence hypothesis for the nuclear part of the interaction and describing it by the phase shifts used in the higher energy region. For 35 MeV pions, an estimate based on the known magnitude of the total $\pi^+ - p$ cross-section shows the Coulomb effects to reach 50% for a scattering angle of the order of 50° in the centre-of-mass system. A.

539.18

1936. Lifetimes of the μ^--meson stopped in Li, Be and C. W. E. Bell and E. P. Hincks. Letter in *Phys. Rev.*, **88**, 1424 (*Dec.* 15, 1952).

The time distribution of 90 000 delays in the range 1–11 sec between stopping and emission of decay electrons was determined for the sea-level mixture of $(\mu^+ + \mu^-)$. The results: $\tau^-(\text{Li}) = 2{\cdot}15 \pm 0{\cdot}09$, $\tau^-(\text{Be}) = 2{\cdot}05 \pm 0{\cdot}06$, $\tau^-(\text{C}) = 1{\cdot}98 \pm 0{\cdot}06$ sec lead to $\tau^-(\text{decay}) = \tau^+ = 2{\cdot}22 \pm 0{\cdot}02$ μsec. W. J. SWIATECKI

539.18

1937. The coupling constant of the nucleon-μ-meson interaction. M. A. Preston and M. F. Duret. Letter in *Phys. Rev.*, **88**, 1425 (*Dec.* 15, 1952).

The probability for the capture of a μ-meson from the K-shell by a C^{12} nucleus is calculated using (1) a "gas" model with (*a*) a Gaussian (*b*) a $(\alpha^2 + p^2)^{-2}$ momentum distribution and (2) a shell model for C^{12}. The coupling constant G_μ required to fit the experiments of Bell and Hincks (preceding abstract) is $2{\cdot}5 - 5{\cdot}0 \times 10^{-48}$ erg cm^3. W. J. SWIATECKI

539.18

1938. The ratio of positive to negative π-meson production from deuterium. J. Carothers and C. G. André. Letter in *Phys. Rev.*, **88**, 1426 (*Dec.* 15, 1952).

This was measured for mesons emitted at 0° to the incident 340 MeV proton beam. For most meson energies the ratio is much larger than expected from a theoretical estimate of Noyes [Abstr. 5746 (1951)]. J. M. CASSELS

539.18

1939. The π^+ to π^- ratio from proton bombardment of deuterium. M. A. Ruderman. Letter in *Phys. Rev.*, **88**, 1427 (*Dec.* 15, 1952).

The high value of the ratio (see preceding abstract) implies a small cross-section for the reaction $p + n = \pi^- + 2p$. This can be explained theoretically if isotopic spin is conserved in the reaction. It is assumed that the pions are emitted into p-states and that the pion-nucleon interaction is strong only in states of isotopic spin $\frac{3}{2}$. J. M. CASSELS

539.18

1940. Multiple Coulomb scattering of high energy pions in photographic emulsions. M. Backus, J. J. Lord and M. Schein. Letter in *Phys. Rev.*, **88**, 1431 (*Dec.* 15, 1952).

The small angle scattering of 218 MeV negative pions recorded in Ilford G.5 emulsions has been measured by the sagitta method using tracks whose average range in the emulsion was 8000 microns. The values of the scattering factor for several cell lengths are given and are shown to be slightly less than the theoretical values. A. C. COATES

539.18

1941. Radiative corrections to meson production by photons. H. Lehmann. *Ann. Phys.* [*Leipzig*] **11**, *No.* 1, 25–32 (1952) *In German.*

The g^2-corrections to the differential cross-section for positive (pseudoscalar) meson production by photons incident on protons are calculated, assuming pseudoscalar meson-nucleon coupling. For the total cross-section, the proportional correction $\delta\sigma/\sigma$ is always less than $0{\cdot}1\ g^2/4\pi$. R. H. DALITZ

539.18

1942. Meson production as a shock wave problem. W. Heisenberg. *Z. Phys.*, **133**, *No.* 1–2, 65–79 (1952) *In German.*

The production of many mesons in a collision of

nucleons is described as a shock wave process governed by a non-linear wave equation. The quantum features can be treated approximately according to the correspondence principle, since high quantum numbers are involved. From the discussion of the solutions of the wave equation predictions are made regarding the energy and angular distribution of various meson types. W. J. SWIATECKI

539.18

1943. The decay of V^0 particles. R. B. LEIGHTON, S. D. WANLASS AND C. D. ANDERSON. *Phys. Rev.*, **89**, 148–67 (*Jan.* 1, 1953).

In a set of 23 000 cloud-chamber photographs taken in a study of penetrating showers, 134 examples of the decay of neutral V-particles, and 18 of the decay of charged V-particles, were observed. An analysis of the 152 examples leads to the following principal conclusions: (1) V-particles result from the impact of mesons and probably also of nucleons, upon nuclei. (2) V-particles are generally produced singly and not in pairs. (3) Two independent kinds of data, one based on measurements of angles and other purely spatial relationships, and the other based on measurements of momentum and specific ionization, lead to the conclusion that more than 80% of these neutral V-particles decayed by the production of a heavy positive and a light negative particle. The mass of the heavy positive particle in most instances was consistent with that of a proton, but in a few cases may have been somewhat less. The negative particle appeared most often to be a π-meson, although in a few cases a μ-meson was indicated. In about 7% of the cases, the positive particle was light and had a mass consistent with that of a π or μ-meson. In these cases the mass of the negative particle was not well determined. So far, therefore, in these investigations, there is no direct evidence that a neutral V-particle decays into two π-mesons, or into a positive π-meson and a negatively charged proton, although a few cases may be so interpreted. (4) The data are consistent with the assumption of a two-body decay for a majority of the neutral V-particles, and therefore a rather extensive analysis is given based upon this assumption. (5) The energy release, or Q-value, of the decay of neutral V-particles was computed, on the assumption of a two-body decay, for those cases in which the production of a heavy positive particle was clearly indicated, and where momentum measurements were possible. On the assumption of a decay into a proton and a π^--meson, the Q-values obtained ranged from 10 MeV to about 100 MeV. The great majority of cases, however, may be described in terms of discrete Q-values at 35 ± 3 MeV, and 75 ± 5 MeV, although, of course, the data are consistent with distributions about these values. For the same set of cases, if the positive particle is assumed to be as light even as $1250m_e$, and/or the negative particle is assumed to be a μ-meson, the distribution of Q-values is not greatly changed, and the apparent necessity for at least two different Q-values remains. In those few cases mentioned in (3) above, in which the positive particle was light, and in which the mass of the negative particle was undetermined, the energy release, computed on the basis of a two-body decay, depends upon the assumed identity of the decay products, and is about 100–130 MeV for the assumption that two π-mesons are produced, about 50–80 MeV for a positive π-meson and a negative τ-meson, and about 30–80 MeV for a positive π-meson and a negative proton. (6) The rest mean lifetime of V^0-particles, which appear to yield protons and π^--mesons as decay products, was found to be $1{\cdot}6\times10^{-10}$ sec for 26 cases having Q-values greater than 50 MeV, and $2{\cdot}9\times10^{-10}$ sec for 48 cases having Q-values less than 50 MeV, on the assumption of a two-body decay. In view of the rather poor statistics, the above two lifetimes are consistent with a single value, and lead to an average of $2{\cdot}5 \pm 0{\cdot}7\times10^{-10}$ sec. The above lifetimes are not appreciably changed if a multi-body decay of the neutral V-particle is assumed. (7) The data are not adequate to distinguish conclusively between a two-body and a multi-body decay, and, therefore, a discussion is also given in terms of a variety of possible decay schemes of the neutral V-particle. A.

539.18

1944. A study of neutral V particles. W. B. FRETTER, M. M. MAY AND M. P. NAKADA. *Phys. Rev.*, **89**, 168–80 (*Jan.* 1, 1953).

The V particles produced in penetrating showers have been studied in a cloud chamber containing lead plates. The results can be interpreted in terms of two types of neutral unstable particles, $V_1^0 \rightarrow p + \pi$ and $V_2^0 \pi + \pi$, although other possibilities are not excluded by the data. Analysis of the dynamics of three-particle decay indicates that such a process must still be considered as possible. The lifetimes of the particles have been calculated, taking into account the bias introduced by the finite size of the cloud chamber. If average values for the masses of the unstable particles are used, the lifetime for the V_1^0 is $(10 \pm 7)\times10^{-10}$ sec and for the V_2^0 is $(4 \pm 3)\times10^{-10}$ sec. A.

539.18

1945. The mesonic Auger effect. G. R. BURBIDGE AND A. H. DE BORDE. *Phys. Rev.*, **89**, 189–93 (*Jan.* 1, 1953).

A simplified nonrelativistic theory of the mesonic Auger effect is presented and discussed. Comparison is made between the predicted and observed numbers of Auger electrons emitted in μ^--meson capture processes. A.

539.181

1946. Electric resonance transitions in a tapered electric field. J. N. GOLDBERG, J. W. TRISCHKA AND P. G. BERGMANN. *Phys. Rev.*, **89**, 278–81 (*Jan.* 1, 1953).

The broadening of the spectral lines produced by small inhomogeneities in the homogeneous C-field of the molecular beam electric resonance apparatus is investigated. The inhomogeneities are represented as an arbitrary function of time because of the flight of the molecules through the field. The transitions investigated occur between states which are the instantaneous solutions of the Stark effect problem in which the effects of nuclear molecular interactions are neglected. A solution is obtained for the probability amplitudes for a transition such that $\Delta J = 0$ and $\Delta m = \pm 1$ by considering a linear combination of the solutions for the case in which

there are no inhomogeneities. As an example, the inhomogeneity of the *C*-field is considered as represented by a linear taper. In this case the amount of line broadening depends on the ratio of the amplitude of the taper to the amplitude of the r.f. field which induces the transitions. Because under optimum operating conditions the product of the r.f. field and the homogeneous field is kept constant, the inhomogeneities have a greater effect in strong than in weak *C*-fields. The line broadening, however, is considerably smaller than one might estimate from the energy level difference computed for two perfectly homogeneous fields having respectively field intensities equal to the two extreme values of the tapered field. A.

539.185

1947. A neutron detection system for use with pulsed accelerators. J. Halpern, A. K. Mann and R. Nathans. *Rev. sci. Instrum.*, **23**, 678–80 (*Dec.*, 1942).

Description is given of a neutron detection system which utilizes the time necessary for slow neutrons to diffuse in a moderating medium for turning on a counter between pulses of an accelerator. The apparatus has a detection efficiency of 0·5% over a wide range of neutron energies. The arrangement of apparatus, circuitry details and performance characteristics are described. A.

539.185

1948. On the "capture scattering" of fast neutrons. T. Wakatsuki. *J. Phys. Soc. Japan*, **8**, 1–6 (*Jan.–Feb.*, 1953).

The differential scattering cross-sections of Li–D neutrons were measured for 11 elements at scattering angle of 90 degrees. The neutron detector was an ionization chamber connected to an electrometer whose energy sensitivity can be changed to some extent by the change of filling gas and its pressure. Intensities of scattered neutrons observed with the chamber filled with high pressure methane, whose sensitivity is expected to be nearly constant through the energy region concerned, agreed well with the values calculated from the differential scattering cross-sections which were assumed to be equal to $\sigma/2 \cdot 1/4\pi$, σ being the total cross-sections. Intensities of scattered neutrons observed with hydrogen-filled chamber with greater sensitivity on the lower energy side showed 30 to 60% higher values than expected by the same calculation. These results support the view that (1) half of the total cross-section is "capture scattering," and (2) in "capture scattering" process, neutrons are scattered isotropically with less energy than the primary neutrons. A.

539.185.7

1949. Determination of neutron resonance parameters from measurements of the absorption integral: application to the main resonance of uranium-238. G. v. Dardel and R. Persson. Letter in *Nature* [*London*] **170**, 1117–18 (*Dec.* 27, 1952).

Formulae are derived for deducing the cross-section σ_0 at resonance and the width of the Breit–Wigner formula from the variation of the absorption integral with absorber thickness, taking account of Doppler broadening. For U^{238} they give $\sigma_0 = (3100$ to $6700)$ barns. W. J. Swiatecki

STRUCTURE OF SOLIDS 539.2

539.211

1950. On the refraction of cracks due to shocks. N. Terao. *J. Phys. Soc. Japan*, **7**, 631–3 (*Nov.–Dec.*, 1952) *In French.*

An uniform dilatational stress was produced in a thin layer of resin melted on a metallic tray by rapid cooling. This layer of resin held on the tray was floated on water and mechanical shocks were given by electric discharges at two or three adjacent points near the bottom of the tray. The refractions of the cracks starting from each of these points was studied. At the places where $\alpha > 90°$ (α, angle between the direction of the crack starting from one of the sources A′ and that of the shock wave from the other source A), the cracks refracted towards the point A, while if $\alpha < 90°$, the cracks refracted in the direction diverging from the point A. The velocity of propagation of these cracks was estimated from the relation between the distances travelled by the crack and the shock wave. A.

539.211

1951. Mechanism of fracture of concrete. F. A. Blakey. Letter in *Nature* [*London*] **170**, 1120 (*Dec.* 27, 1952).

Studies of the distribution of strain in various types of concrete specimen suggest that in all specimens failure first occurs when the tensile strain is about 10^{-4}. In compression tests on cylinders, this strain occurs when the load is about 50% of the ultimate, and in unreinforced flexural specimens at about 90% of the ultimate. A noticeable decrease in the slope of the stress/strain curve is thought to coincide with the formation of tensile cracks on the circumference of a cylindrical compression specimen. The ratio of the stress at fracture to the uniaxial tensile strength is plotted for various hypotheses of failure and for various assumed values of Poisson's ratio. The diagram shows that the limit provided by each hypothesis depends upon Poisson's ratio to such an extent that it is difficult to choose any one hypothesis. A. C. WHIFFIN

539.211 : 535.417

Application of multiple-beam interferometry to the study of surface polish. *See Abstr.* 1559

539.211 : 539.434

1952. Failure and fracture of metals from the standpoint of the stochastic theory. T. Yokobori. *J. Phys. Soc. Japan*, **8**, 104–6 (*Jan.–Feb.*, 1953).

The phenomena of failure and fracture of metals were treated as a Markoff process or chain. In the fundamental types of failure and fracture, the physical meanings of transition probabilities were interpreted and they were found to correspond to the nucleation rate or reaction rate. The following fundamental features were given a unified interpretation: (1) the dependence of strength on stress velocity or deformation velocity and temperature; (2) the dependence of the time for creep fracture on stress and temperature; (3) many features in the endurance limit and the dependence of the number of repeated cycles for fatigue fracture on the stress range; (4) the size effect; (5) the fluctuation characteristics; (6) ductility transition phenomena. A.

539.211 : 539.5

1953. Ductility transition and cold brittleness. T. Yokobori. *J. Phys. Soc. Japan*, **8**, 101–7 (*Jan.–Feb.*, 1953).

The occurrence of the change of fracture from ductile type to brittle one which is often called "cold brittleness" is studied from the standpoint of the stochastic theory. Failure and fracture processes were treated as reaction rate process. The relation between deformation velocity, V_B, and the absolute temperature for brittle fracture was obtained in the form: $\log V_B = -(Q/RT) + c_0$. The effect of radius of notch on the transition, the size effect and the scatter of the brittle strength were also interpreted from the same standpoint. In the case in which the Cottrell–Bilby mechanism for yielding, and nucleation process for brittle fracture, respectively, are regarded as rate-determining, similar results can also be obtained. A.

539.213

1954. Properties of vitreous water. J. A. Pryde and G. O. Jones. *Nature* [*London*] **170**, 685–8 (*Oct.* 25, 1952).

By various ingenious methods the authors have succeeded in preparing sufficient vitreous water to measure a number of its properties. Evidence was obtained that water forms a glass with transformation temperature between −150°C and −125°C, while it was found that the activation energy for viscous flow can exceed the heat of evaporation. T. C. TOYE

539.213

1955. Bond differences between crystalline and amorphous states of aggregation. A. Smekal. Note in *Naturwissenschaften*, **39**, *No.* 2, 505–6 (1952) *In German.*

In the case of substances that can exist either in a crystalline or in an amorphous state, the irregularity inherent in the latter cancels all co-operative properties depending on the crystal lattice structure, viz. both the macroscopic (e.g. anisotropy) and the microstructural (e.g. the electronic metallic bonds). Thus the crystalline substances with "metallic partial bonds" (e.g. selenium), lose this property in the amorphous state. For binary compounds, the amorphous states are characterized by lower co-ordination numbers. Finally, the variability of the bond angles and bond lengths, indispensable for the vitreous-amorphous states, can be realized, in the first place, by "angular" bridging bonds. F. LACHMAN

539.215 539.374

1956. Application of gasdynamical method to soil mechanics and theory of plasticity. I. N. Inoue. *J. Phys. Soc. Japan*, **7**, 604–9 (*Nov.–Dec.*, 1952).

Discusses the two-dimensional isostatical problem in the mechanics of either a perfectly plastic or a pulverulent body, obeying the maximum shear theory in "plane strain" or Coulomb's plasticity condition in "plane stress" respectively, as a kind of gasdynamics of the hypothetical gas here introduced. This gas is non-viscous compressible and obeys the following pressure-density relation: $p/\rho^{\gamma} = \text{const.}, -1 < \gamma < 1$, or $p/\log \rho = \text{const.}$ The velocity of sound in the gas at rest is chosen to be zero in either case. By applying the hodograph method to the gas flow, a general solution of the problem is obtained. After considering simple waves and shocks in gas flow, an extension of the analogy to plastic bodies of revolution is briefly mentioned. A.

539.215 539.374

1957. Application of gasdynamical method to soil mechanics and theory of plasticity. II. N. Inoue. *J. Phys. Soc. Japan*, **7**, 610–18 (*Nov.–Dec.*, 1952).

The method of Pt I is applied to practical problems, resulting in a demonstration of several plastic states of stress, slip lines and isostatics. There are illustrated, with mathematical expressions, figures and photographs, slip lines on the surface of a metal or soil produced by forcing a cylindrical punch into it, those in a plastic mass pressed between two rough parallel or inclined plates, regular markings on the face of a compressed prism of paraffin, and spiral cracks in safety glass disks broken under a concentrated load, etc. A.

539.215.4 : 531.791

Automatic method of granulometric analysis. *See Abstr.* 1403

539.216 : 539.4.016.2

1958. Drawing synthetic fibres. I. Marshall and A. B. Thompson. Letter in *Nature* [*London*] **171**, 38–9 (*Jan.* 3, 1953).

Two related problems are shown to be capable of treatment by considering the temperature-load-extension characteristic of the material. These are (*a*) behaviour under continuous drawing and (*b*) the formation and maintenance of a "neck." It appears that necking is due to the self-heating of the material to the point where the effective load-extension curve becomes horizontal. The essential criteria for its occurrence are summarized. A. J. KENNEDY

539.217

1959. The diffusion of antimony in silver single crystals. L. Slifkin, D. Lazarus and T. Tomizuka. Letter in *J. appl. Phys.*, **23**, 1405 (*Dec.*, 1952).

Using extremely low concentrations of Sb, in the form of radioactive Sb^{124}, the diffusion coefficient, measured by a standard method, was found to be $D = 0{\cdot}29 \exp(-39\,400/RT)$. A. D. LE CLAIRE

539.217

1960. Effect of impurities on the self-diffusion of silver. R. E. Hoffman and D. Turnbull. Letter in *J. appl. Phys.*, **23**, 1409–10 (*Dec.*, 1952).

The activation energy for self-diffusion of Ag in a series of dilute Ag–Pb alloys (0–1·3 at. % Pb) differs little from that for pure Ag, while the diffusion coefficient itself increases linearly with Pb content. It is considered that in addition to the normal mechanism responsible for the self-diffusion of pure Ag, there is also a Pb-assisted transport of Ag atoms, perhaps by an exchange of Pb and Ag atoms facilitated by vacancies trapped near Pb atoms. A. D. LE CLAIRE

539.217

1961. The evolution of gas from nickel plate. T. Arizumi and S. Maekawa. *J. Phys. Soc. Japan*, **8**, 87–91 (*Jan.–Feb.*, 1953).

Quantitative analyses of gas were carried out with a micro-gas analyser similar to Prescott and Morrison's

apparatus. The main components of the evolved gas were CO, CO_2, H, water vapour and N. The rate of evolution of CO was found to be determined by the diffusion of O atoms through the metal. A considerable quantity of gas was evolved from the electrolytic Ni, but below 450°c only H was released, while at higher temperature some other gases were extracted. The activation energies for degassing of H were about 5 kcal/g.atom and 12 kcal/g.atom for low and high temperature regions respectively. This suggests that there are two mechanisms for the diffusion of H: one is the normal lattice diffusion and the other is the rift or crystal boundary diffusion. A.

539.217 : 533.15

The mechanism of diffusion of helium in zircons. *See Abstr.* 1426

539.217 : 536.75

1962. Entropies of activation in metallic diffusion. G. J. DIENES. *Phys. Rev.*, **89**, 185–8 (*Jan.*1, 1953).

The various contributions to the entropy of activation for metallic diffusion are examined theoretically. In particular, the entropy contribution arising from the altered vibrational frequencies around the saddle point is estimated. It is concluded that negative over-all entropies of activation are theoretically permissible and are likely to arise when the over-all activation energy is small. A.

539.217 : 539.374 : 541.64

1963. Viscosity, self-diffusion, and allied effects in solid polymers. F. BUECHE. *J. chem. Phys.*, **20**, 1959–63 (*Dec.*, 1952).

An attempt has been made to explain the observed viscous behaviour of bulk polymers. It is found that the viscosity and diffusion may be represented by a theory which takes into account the coupling together of the molecules. Two equivalent treatments are given. One makes use of a segmental friction factor in the same manner as the common formulation of dilute solution viscosity of polymers. The second method uses the concept of segmental jumping. Since both are equivalent, an expression for the friction factor is found in terms of the segmental jumping frequency. Using this fact it is possible to calculate the segmental jumping frequency from bulk viscosity data. A simple application leads to the result that the jumping frequency is about $0{\cdot}3\ \text{sec}^{-1}$ at the transition temperature in polystyrene. In addition a simple relation is found to hold between bulk viscosity and diffusion constant. The proportionality constant is easily evaluated and so one is now able to obtain self-diffusion constants directly from viscosity data. A.

539.217 : 539.38

1964. Polygonization during diffusion. R. W. BALLUFFI. Letter in *J. appl. Phys.*, **23**, 1407–8 (*Dec.*, 1952).

In the diffusion zones of both CuNi and AuAg samples thermal etching revealed a sub-grain structure, finest near to the diffusion interface and becoming coarser with distance from it. X-ray examination and the slight bending at sub-grain boundaries of slip lines introduced by straining after diffusion, indicated a slight disorientation between grains. Such polygonization is attributed to inhomogeneous stresses set up during the interdiffusion of two metals.

A. D. LE CLAIRE

539.217 : 541.64

1965. The measurement of self-diffusion in solid polymers. F. BUECHE, W. M. CASHIN AND P. DEBYE. *J. chem. Phys.*, **20**, 1956–8 (*Dec.*, 1952).

The self-diffusion constant of the macromolecules in plasticized polystyrene and pure poly-*n*-butyl acrylate has been measured over a wide variety of conditions by a radioactive tracer technique. Well-characterized polymer fractions were used throughout. Simultaneous measurements of the bulk viscosity were also made. From the data obtained one is able to show that within experimental error the product of the self-diffusion constant and the bulk viscosity is equal to a constant. This constant has been predicted by theory, and the agreement with the experimental value is good. Therefore, it appears possible to obtain diffusion constants directly from bulk viscosity data. A.

539.23 : 548.7

1966. The decomposition of thin oriented silver halide layers. D. W. PASHLEY. *Phil. Mag.*, **43**, 1028–41 (*Oct.*, 1952).

Thin layers of oriented silver halides (AgCl, AgBr and AgI) have been prepared in various ways, and their stability to electron (30–60 kV) bombardment has been investigated. Unstable specimens are found to decompose to give highly oriented Ag, in the case of AgCl and AgBr, but to give mainly randomly oriented Ag in the case of AgI. AgCl also gives rise to highly oriented Ag during u.v. irradiation. Chemical development of the halides produced randomly oriented Ag, except when the halide was supported on a metallic Ag crystal substrate. In this latter case the developed Ag formed in an oriented fashion on the Ag substrate. Diffuse streak patterns were observed from the Ag halides and their origin is discussed. A.

539.231 : 541.64

1967. Preparation and study of some thin films of high polymers used in nuclear physics. S. VUCCINO. *J. Phys. Radium*, **13**, 543–9 (*Nov.*, 1952) *In French.*

Various high polymers have been studied with a view to the preparation of thin films as supports for radioactive sources and as windows in G.M. counters. The technique employed is to spread the substances, from a solution, on to a water surface or in some cases on a glass surface. The author has studied the effect of various solvents and of changes in the conditions of spreading. In addition, the physical and chemical properties of the films have been investigated, e.g. mechanical strength, ohmic resistance, resistance to acids. It is concluded that films can be prepared in this way with a thickness of $1\ \mu\text{g/cm}^2$ which are comparable to the best described in the literature. J. IBALL

539.234 : 548.7

1968. Anisotropic lattice distortion in evaporated deposits of face-centred-cubic metals. E. C. WILLIAMS. Letter in *Research*, **5**, 392–3 (*Aug.*, 1952).

Precision measurements on thin metallic films give rise to anomalous values of the radii of electron diffraction rings. These are interpreted as being due to the effect of single dislocations. J. THEWLIS

539.26

969. X-ray scattering of coals. J. B. NELSON. letter in *Research*, **5**, 489–90 (*Oct.*, 1952).

Scattering curves from 400Å to 2·5Å spacing are iven for 9 vitrinites, free from inorganic matter, ith carbon content from 77 to 93%. Several deduc- ons, including an atomic radial distribution curve, re made. A. R. STOKES

539.26

970. An X-ray investigation of cokes. A. E. RESLER, V. I. ZABAVIN AND A. M. ZUBKO. *Dokl. kad. Nauk SSSR*, **87**, *No.* 4, 567–70 (1952) *In ussian.*

Radial density distributions were obtained by ourier transformation of the angular variation of the ntensity of X-ray scattering from various samples of oke. The latter had been formed at 350–1200°. The esults indicate that the basic materials are not three- imensional crystals but blocks or plates laid parallel o each other but with their lattices in arbitrary rientations. The growth of these lattices on heating s due to the liberation of carbon in the process of riving off the volatiles. A. L. MACKAY

539.26

971. The scattering of X-rays by crystals of an geing alloy. A. M. ELISTRATOV. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 4, 581–4 (1952) *In Russian.*

Theoretical. Expressions are derived for the scatter- ng to be expected from a crystalline block A, con- aining a number of very small, randomly distributed, nclusions of another crystalline material B. In all ases regions of anomalous intensity are to be found ound lattice points in the reciprocal lattice of A.

A. L. MACKAY

539.26

1972. Small-angle X-ray scattering. W. EHRENBERG AND A. FRANKS. Letter in *Nature* [*London*] **170**, 1076–7 (*Dec.* 20, 1952).

X-ray diffraction photographs of organic materials with large lattice spacings (fibres, crystalline viruses) were obtained using a bent optical flat to form an mage on the film of a foreshortened X-ray focus 5 μ wide. With a focus-film distance of 30 cm, a spacing of 350Å could be resolved; with favourable specimens the resolving power could be increased by a factor two. Photographs are shown of collagen (exposure times 3 hr, 30 min) and tobacco mosaic virus gel (3 hr). J. A. FRANKS

539.27

1973. Electron microscope study of electrically precipitated deposits. M. PAUTHENIER AND R. CHALLANDE. *C.R. Acad. Sci.* [*Paris*] **235**, 1113–15 (*Nov.* 10, 1952) *In French.*

An extension of optical studies [Abstr. 8299 (1950)], showing that, as expected, very much smaller particles are deposited than can be seen optically. The presence of $\frac{1}{50}$ μ particles is established. R. S. PEASE

539.27

1974. Electron diffraction study of the changes in thin films of Sb, As, Bi obtained by thermal vaporization in the diffraction enclosure. P. CONJEAUD. *C.R. Acad. Sci.* [*Paris*] **235**, 1213–15 (*Nov.* 17, 1952) *In French.*

Sb is amorphous when deposited but under the action of the electron beam becomes crystalline. As remains amorphous but Bi is crystalline immediately on deposition. J. THEWLIS

539.27

1975. The production of specimen mounting grids for the electron microscope. C. E. CHALLICE AND C. D. SUTTON. *Brit. J. appl. Phys.*, **3**, 384–5 (*Dec.*, 1952).

A photographic etching technique has been used to produce specimen mounting grids for electron microscopy. The method may be used to produce grids of any desired shape or size. A.

539.27

1976. Electron diffraction investigation of polished surfaces. T. S. RENZEMA. Letter in *J. appl. Phys.*, **23**, 1412 (*Dec.*, 1952).

Experimental evidence is available that the diffuse electron diffraction patterns obtained from polished surfaces are commonly due to adsorbed hydrocarbon films and not to the material which has been polished.

J. THEWLIS

539.27

1977. Electron diffraction studies on oxide films formed on metals and alloys. II. Selective oxidation of alloys. G. HONJO. *J. Phys. Soc. Japan*, **8**, 113–18 (*Jan.–Feb.*, 1953).

For Pt I, see Abstr. 5335 (1950). Surface oxidation products on various alloys due to varying oxidizing conditions within the range of 300–900°c for temperature and 10^{-4}–760 mm Hg for air pressure are studied by the electron diffraction method. Alloys studied are copper alloys containing 0·3% Be, 0·5% Al, 0·1% Mg, 7% Mn and 7% Ni and that of iron with 13% Al respectively. The selective oxidation or the phenomenon that the baser component of alloy is oxidized selectively in spite of its much lower content in the mother alloy than the other was found to occur generally in these alloys when the air pressure is sufficiently low and the temperature is high enough. High yield of the secondary electron emission of Be–Cu alloy is concluded to be due to the selective oxidation product BeO having a particular orientation grown on this alloy. An unknown oxide of Ni of a spinel type structure is found on 7% Ni–Cu alloy. A.

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31

1978. On stability and the intrinsic curve. M. DAVIN. *C.R. Acad. Sci.* [*Paris*] **235**, 691–3 (*Oct.* 6, 1952) *In French.*

An elastic potential is deduced assuming Cauchy's attractive radial interactions from which the conditions of stability and the corresponding intrinsic curves are deduced. J. E. CAFFYN

539.32

1979. Amplitude pulsations in the vibrational strain pattern of metal single crystals. J. W. MARX. Letter in *J. appl. Phys.*, **23**, 1406–7 (*Dec.*, 1952).

The assymetry at high stresses of the resonance curves of Zn specimens driven in transverse vibration

at audio-frequencies, may be as well explained on the assumption of a continuous amplitude dependence of the elastic moduli, as on that suggested by Takahashi [Abstr. 7600 (1952)] of discontinuous changes associated with slip band formation. A. D. LE CLAIRE

539.32

1980. Method of determining the mechanical parameters of rubber-like materials at acoustic frequencies. G. K. DEMISHEV. *Zh. eksper. teor. Fiz.*, **22**, *No.* 5 617–23 (1952) *In Russian.*

The method presented permits of determining the shear modulus and the corresponding tan of the mechanical loss angle of elastomers at shear deformations produced at acoustic frequencies. It is based on the principle of a standing wave set up in the specimen. The set-up consists of a generator of sinusoidal acoustic waves, feeding the latter to a piezo-vibrator with 4 Seignette crystals between which the band-shaped specimen is held, a frequency meter, phase-shifter and c.r.o. The phase difference between the vibrator and receiver, corresponding to the length of the acoustic wave in the specimen, and also the amplitude of the oscillations of the receiver may be determined from the form and dimensions of the Lissajous figures appearing on the oscillographic screen. The full theory of the method, based on the inhomogeneous 3rd order equation of a shear wave propagated through a viscous-elastic medium, is given and shown to yield the phase curves *v.* specimen thickness in fractions of wavelength. A detailed description of the apparatus and test results conclude the paper. B. F. KRAUS

539.32 : 537.531 : 535.33.07

1981. A critical evaluation of the Norelco high angle X-ray spectrometer for elastic strain measurements. S. R. MALOOF AND H. R. ERARD. *Rev. sci. Instrum.*, **23**, 687–92 (*Dec.*, 1952).

The theory of measuring elastic strains in metals with an X-ray spectrometer is discussed and comparison is made with the X-ray back-reflection film method. It is shown that the accuracy attained in the determination of the surface biaxial stress sum from measurements on sharp diffraction lines with the spectrometer is equally as good as, or better than, that attained with the usual film techniques. An example is given of the determination of the biaxial stress sum with the spectrometer in a steel hardened to Rockwell C55. It was not possible to make the same determination photographically. The effect of elastic anisotropy on X-ray stress determinations is briefly discussed. It is shown that the error in the determination of the stress sum due to an improper choice of elastic constants is less than that due to the normal experimental errors. An example is given of an X-ray determination of Poisson's ratio in different crystallographic directions in a FS8742 steel. A.

539.373

1982. The deformation of silver at high temperature. A. P. GREENOUGH. *Phil. Mag.*, **43**, 1075–82 (*Oct.*, 1952).

The deformation of Ag wires at high temperatures and low applied stresses has been investigated experimentally. Considerable evidence has been obtained that the crystal grains in the wires deform by the self-diffusion mechanism postulated by Nabarro and considered in detail by Herring (1950). A new explanation of the development of kinking is advanced to account for the experimental observations. It is shown that surface energy effects can give rise to offsetting in a direction which causes the wires to shorten. A.

539.373

1983. The Cottrell–Bilby theory of the yielding of iron. T. YOKOBORI. Letter in *Phys. Rev.*, **88**, 1423 (*Dec.* 15, 1952).

A modification of the Cottrell–Bilby theory is proposed, based on the author's treatment of the yield phenomenon as a Markoff process [see Abstr. 7602 (1952)]. J. G. OLDROYD

539.373

1984. Criterion for the onset of slip in metallic polycrystals. F. ROHNER. *Z. angew. Math. Phys.*, **3**, *No.* 5, 383–90 (1952) *In German.*

Slip is possible in a crystallite, without any work being done against bonding forces, whenever such slip would reduce the elastic strain energy. This principle is used to calculate a lower limit for the stress required to cause slipping, which is inversely proportional to the mean free path of slip. Measured elastic limits for wrought and for sintered pure Al samples confirm the theory. The prediction that a perfect crystal would have vanishingly small rigidity is supported by extrapolation from observations on single crystals with unavoidable slight imperfections. J. G. OLDROYD

539.389.3

1985. Towards a uniform theory of relaxation phenomena. E. HIEDEMANN AND R. D. SPENCE. *Z. Phys.*, **133**, *No.* 1–2, 109–23 (1952) *In German.*

A functional theory of relaxation is discussed and also the behaviour of discreet and continuous relaxation spectra. T. C. TOYE

539.389.4

1986. Hysteresis in rubber. D. M. DAVIES. Letter in *Nature* [*London*] **170**, 937 (*Nov.* 29, 1952).

The slope and area of a hysteresis loop vary if the starting strain is varied. The general definitions and usefulness of the terms "resilience" and "percentage damping" are discussed. J. G. OLDROYD

539.4.01 : 666

1987. A statistical treatment of the resistance of glass to rupture. On the influence of temperature. N. TERAO. *J. Phys. Soc. Japan*, **7**, 627–30 (*Nov.–Dec.*, 1952) *In French.*

The effect of temperature on the fluctuation of the strength of glass under increasing load on the centre of a glass plate suspended freely at the ends was studied. The region of temperature was between room temperature and 300°c. $\mu(t)$, the probability of breakdown at the time t, is described as follows:

$$\mu(t) = \alpha \exp\left[-\frac{E_0(T) - \beta f}{kT}\right]$$

Here, $E_0(T)$ is the activation energy for breakdown when there is no applied load, f the load, βf the energy applied by external load, T the absolute temperature and k Boltzmann's constant. According to

he result of experiment, β is not constant but depends n the temperature, having a minimum at about 50°C. The magnitude of E_0 is some kcals/mol and ncreases with the temperature. A.

539.4.014

988. Yield points in bending experiments on zinc rystals. M. J. DUMBLETON AND B. W. HOWLETT. *roc. Phys. Soc.* [*London*] *B*, **65**, 882–6 (*Nov.*, 1952).

It is shown that sharp yielding can be observed in reviously unstrained Zn crystals by means of bending xperiments devised to avoid premature overstraining f the specimen. This resolves a difficulty in the nterpretation of previous tensile experiments on rystals which show the yield phenomenon. A.

539.4.015

989. Some observations on the yield point in zinc. I. L. WAIN. *Proc. Phys. Soc.* [*London*] *B*, **65**, 86–96 (*Nov.*, 1952).

Evidence is given confirming that the yield point n Zn is due to N in solution. The theoretical pre- iction that a yield point should appear in a sus- eptible crystal without the necessity for any prior eformation is verified experimentally, and an explana- ion is given of the observation that a yield point may ppear in a specimen even though free dislocations ave been introduced subsequent to ageing. Under ertain conditions the yield point values in Zn decrease s identical strain-ageing treatments are repeated, and smooth stress–strain curve is ultimately obtained. his is attributed to an accumulation of work harden- ng which causes the dislocation density to increase to uch an extent that the dislocations can no longer be ffectively anchored by the available N atoms. The ifference between this behaviour and that of Fe on epeated strain ageing is discussed. A.

539.4.016 : 539.533

990. Work-hardening of annealed mild steel under tatic and dynamic conditions. A. W. CROOK. Letter n *Nature* [*London*] **170**, 1124–5 (*Dec.* 27, 1952).

The Meyer equation $F = kd^n$, relating the force F vith which a hard ball is pressed into a metal surface nd the diameter d of the impression, is found to hold n static tests on annealed mild steel with $n = 2{\cdot}39$, nd in dynamic tests in which the maximum force is eached in about 300 μsec with $n = 2{\cdot}20$. This uggests that the material is temporarily work- ardened more in a static than in a dynamic test. In onfirmation of this, the static and dynamic indices ecome equal (2·09) after some prior cold-working. J. G. OLDROYD

539.4.016.2

991. A theory of work-hardening of metal crystals. N. F. MOTT. *Phil. Mag.*, **43**, 1151–78 (*Nov.*, 1952).

A theory of work-hardening is put forward; the alient points are as follows. There are two types of ardening; the normal rapid hardening of cubic netals and the slower hardening characteristic of exagonal crystals and cubic metals under conditions f easy glide. A quantitative theory of the rapid ardening is given. This does not occur unless dis- ocations are retained in the slip planes. The retained islocations are supposed to occur in groups of about 000 at the ends of the slip-bands. The strains round hese groups are responsible for hardening as in Taylor's (1934) theory. The obstacles which stop slip are sessile dislocations, and the formation of sessile dislocations stabilizes the groups of dislocations. It is shown that the formation of slip lines must be a dynamic process, and on this assumption a parabolic stress–strain curve is deduced. Some discussion is given of the formation of vacancies by moving dis- locations, and it is shown that this can account for the clustering of slip lines observed under the electron microscope. The theory agrees qualitatively with observations on the amount of retained energy in a cold-worked metal. A.

539.4.016.2 : 536.48

1992. Cold work studies on copper at low tempera- tures. R. R. EGGLESTON. Letter in *J. appl. Phys.*, **23**, 1400–1 (*Dec.*, 1952).

Copper cold-worked at the temperature of liquid helium is annealed at a temperature between −140°C and 20°C, the course of annealing being followed by means of periodic electrical resistance measurements at 4·2°K. The results suggest two distinct annealing processes, associated with different activation ener- gies, in the temperature ranges below and above −70°C. J. G. OLDROYD

539.431.3 : 548.0

1993. Investigation of fatigue phenomena on mono- crystals of rock salt using an optical method. D. B. GOGOBERIDZE AND I. D. KIRVALIDZE. *Zh. tekh. Fiz.*, **21**, *No.* 10, 1255–61 (1951) *In Russian.*

Optically isotropic specimens, 50 mm long, 5×5 to 10×10 mm² cross-section, cut out of rock salt crystals, were subjected to bending in alternate directions in a single plane by means of an eccentric and a system of springs (at 9 c/s) or an electromagnet fed by a.c. and acting on a spring mounted at the end of the crystal (at 100 c/s). The specimens were inspected in polarized light using a low magnification microscope. A double refraction was observed a long time before failure of the specimens and did not disappear after discontinuing the test. A scratch parallel to the edge of the specimen and perpendicular to the direction of the force produced a local double refraction of light and led to accelerated failure. A scratch on a specimen subjected to fatigue produced a light zone surrounding an intense double refraction region; on a fresh specimen it produced two slight "whiskers," which spread on subjecting the specimen to fatigue testing. A. GELBTUCH

539.576

1994. Theory of mechanical wear. J. F. ARCHARD. Letter in *Research*, **5**, 395–6 (*Aug.*, 1952).

Holm's theory [*Electrical Contacts*, H. Gerkins, Uppsala (1946), p. 214] is modified to allow "*a*" spots to have variable area and to allow for removal of material in lumps. J. E. CAFFYN

539.576

1995. An interferometric investigation of the abrasion hardness properties of diamond. E. M. WILKS. *Phil. Mag.*, **43**, 1140–5 (*Nov.*, 1952).

The abrasion properties of several diamonds have been investigated using a multiple beam interfero- metric technique. The cube, dodecahedron and octa- hedron planes were abraded in various directions using

a special micro abrasion tester. Abrasion only occurred in directions parallel to crystallographic axes; that is in four directions on cube planes and in two on dodecahedron planes, whereas no abrasion at all was produced on either natural or cleavage octahedron planes. Not all these directions were equally favourable; although it was found that an exact orientation reduced the vector effect. Taking the most favourable direction in each case the dodecahedron surfaces were easier to abrade than the cube surfaces. In addition the interferograms show that the abrading wheel moved in both lateral and longitudinal directions whilst abrading and at the same time probably suffered elastic deformation. It can be seen that the sides of an abrasion were highly polished and that there was no large scale deformation of the surrounding surface. A.

539.622

1996. The mechanism of rolling friction. D. TABOR. *Phil. Mag.*, **43**, 1055–9 (*Oct.*, 1952).

An investigation has been made of the friction and surface damage produced when a hard steel ball rolls between flat parallel surfaces of a softer metal. The behaviour may be divided into two parts. When rolling first commences, even at small loads, there is marked plastic flow and the resistance to rolling is due primarily to the plastic displacement of metal ahead of the ball. With successive traversals of the same track there is an increase in track width and a diminution in rolling resistance. An equilibrium state is ultimately reached where no further increase in track width occurs so that the deformations are essentially elastic. The rolling resistance is now constant and is unaffected by boundary lubricants. From a detailed study of the rolling of spheres and cylinders on rubber it is shown that there is no interfacial slip, the whole of the rolling resistance being due to elastic hysteresis losses. It is suggested that in the rolling experiments on metals within the elastic range the resistance to rolling is also due primarily to elastic hysteresis losses. Thus in rolling, there is no "friction" in the conventional sense of the word. A.

539.67

1997. A note on the measurement of damping in vibrating rods. G. G. PARFITT. Letter in *Brit. J. appl. Phys.*, **3**, 332 (*Oct.*, 1952).

A correction to Abstr. 2184 (1952) affecting the final results by $< 1\%$. J. G. OLDROYD

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.2

1998. The system NaCl—H_2O at supercritical temperatures and pressures. C. S. COPELAND, J. SILVERMAN AND S. W. BENSON. *J. chem. Phys.*, **21**, 12–16 (*Jan.*, 1953).

Apparatus and techniques are described for the sampling of one phase of a liquid-vapour equilibrium system at high temperatures and pressures. These have been applied to the system NaCl–H_2O in the supercritical region. Where the experimental ranges overlap the present data are in reasonable agreement with that of previous workers. From the data obtained it has been possible to construct partial phase diagrams of the NaCl–H_2O system and to calculate partial molal volumes of NaCl. The partial molal volumes of NaCl in steam are the largest partial molal volumes ever reported (order of magnitude of -2 litres) and indicate extensive solvation of the solute molecules in the vapour solution. A.

541.123.5

1999. Equilibrium in the exchange of deuterium between ammonia and hydrogen. M. PERLMAN, J. BIGELEISEN AND N. ELLIOTT. *J. chem. Phys.*, **21**, 70–2 (*Jan.*, 1953).

Equilibrium in the reaction $NH_{3(g)} + HD_{(g)} = NH_2D_{(g)} + H_{2(g)}$ was measured in the temperature range 210°K to 295°K. The results may be expressed by the relation $K = 0{\cdot}972 \exp 509/T$. The zero-point energy difference between NH_3 and NH_2D is calculated to be $635 \pm 3\ cm^{-1}$. A.

541.123.5 : 545.844

2000. Ion exchange mechanism and isotherms from deep bed performance. C. N. MERRIAM, JR, R. W. SOUTHWORTH AND H. C. THOMAS. *J. chem. Phys.*, **20**, 1842–6 (*Dec.*, 1952).

The rate laws for diffusion-controlled chromatographic ion-exchange are discussed in connection with their application to deep beds of exchanger. Results of experiments with a carboxylic acid resin indicate that solid diffusion is the rate-determining step under the conditions of the experiments. An estimate is found for the value of the diffusion constant. The information is applied to the computation, from a chromatographic elution, of a Cs–Na isotherm for the exchanger. This result is compared with a direct determination of the isotherm. A.

541.124

2001. The thermal decomposition of potassium azide. P. W. M. JACOBS AND F. C. TOMPKINS. *Proc. Roy. Soc. A*, **215**, 265–77 (*Nov.* 25, 1952).

Measurements of the rate of decomposition of solid K azide in hard vacuum and in a controlled vapour pressure of K are reported. Some observations of *F*-centre formation and decay allow a model for the trapped exciton to be formulated. This concept of a coloration complex is consistent with the previous theory [Abstr. 2017 (1953)] postulated for the photochemical decomposition, with the *F*-centre bleaching rates and with the ineffectiveness of pre-irradiation on subsequent thermal decomposition. The thermal decomposition consists of an initial decay process, associated with anomalous groups of surface defects, followed by a linear process corresponding to an

nterface reaction. Nucleus formation and growth re absent because of the volatility of the metallic roduct. The decomposition is catalysed by the resence of a constant vapour pressure of K, the ncrease in rate being due solely to a reduction in the ctivation energy of the reaction by the provision of lectron traps other than vacant anion sites. A.

541.124

2002. Intramolecular carbon isotope effects in the decarboxylation of malonic acid and bromomalonic acid. P. E. YANKWICH AND E. C. STIVERS. *J. chem. Phys.*, **21**, 61–6 (*Jan.*, 1953).

The observed C^{13} effects are in agreement with the results of other investigators; the C^{14} effects are in partial agreement with earlier published results of one of the authors [Abstr. 3952 (1952)]. The ratio of C^{14} to C^{13} effects is found to be near 3·6. A.

541.126

2003. Detonation in condensed systems. J. TAYLOR. *Oxford: Clarendon Press.* 186 *pp. with* 10 *plates.*

Review in *Phil. Mag.*, **43**, 1113 (*Oct.*, 1952).

541.126

2004. The inhibiting effect of lead tetraethyl. I. The effect of lead compounds on the vapour phase slow oxidation of di*iso*propyl ether and on the ignition of diethyl ether. G. H. N. CHAMBERLAIN AND A. D. WALSH. *Proc. Roy. Soc. A*, **215**, 175–86 (*Nov.* 25, 1952).

The effect of lead tetraethyl on various pressure-temperature regions of ether combustion is described. The inhibiting effect was found to persist after prolonged evacuation of the apparatus. Various experiments suggested that this was due to the deposition of lead oxide. Work has therefore been carried out to determine the effects of the oxides of lead on the slow oxidation and on the ignition of ethers. It is found that lead monoxide gives an inhibiting effect profound, persistent and in every way similar to that of lead tetraethyl. Experiments show that it does this by a surface destruction of chain centres. It is further shown that, on oxidation, lead tetraethyl gives rise to a fog of (probably lead monoxide) particles. Its inhibiting effect is then exerted either by these colloidal particles or by the film of lead monoxide to which they give rise on the walls of the vessel. Lead tetraethyl and lead monoxide inhibit, at both "low" and "high" temperatures, both the slow oxidation of di*iso*propyl ether and the process leading to hot flames of diethyl ether. They have no effect on the induction period preceding a cool flame in diethyl ether and only a slight effect on the cool-flame ignition limit. They both reduce the pressure kick due to a cool flame. These results are briefly discussed and are related to other published work. A.

541.126

2005. Flash X-ray investigations on non-ideal detonation waves. R. SCHALL. *Z. angew. Phys.*, **4**, *No.* 8, 291–3 (1952) *In German.*

Flash X-ray photographs (0·1 μsec exposure) of a detonating stick of compressed T.N.T. (density 1 g/ml, grain size 0·1 to 0·9 mm dia.) show that if the stick is initiated simultaneously over its cross-section, the detonation wave remains nearly plane for a distance equal to several charge diameters; but eventually a stable saucer-shaped wave is set up, as predicted theoretically by Eyring [Abstr. 561 (1950)]. Identifying the high-density region in the wave with the reaction zone, the dependence of reaction-zone thickness (α) upon grain size (d) was observed; these direct measurements are in very close agreement with predictions by Eyring based upon measurements of detonation velocity ($\alpha = 1 \cdot 2$ mm for $d = 0 \cdot 1$ mm; $\alpha = 3$ mm for $d = 0 \cdot 9$ mm). A. SCHOFIELD

541.127

2006. The hydrogen–oxygen reaction sensitized by nitrosyl chloride. J. CHANMUGAM AND P. G. ASHMORE. Letter in *Nature* [*London*] **170**, 1067–8 (*Dec.* 20, 1952).

Measurements of the induction period of the H_2–O_2 reaction at 360°C and 180 mm Hg pressure, with small additions of NO (0·25–10 mm Hg) and NOCl (0·05–0·60 mm Hg) have been made (*a*) when the additives are admitted to the reaction vessel simultaneously with the main reactants, (*b*) when the additives are admitted before the main reactants. It was found that pre-mixed NOCl gives induction times of 10–20 sec; but if NOCl is admitted more than 30 sec before the main reactants, ignition is instantaneous. If NO is admitted before the main reactants, ignition is instantaneous; but if also sufficient NOCl (e.g. 0·5 mm Hg) is run in with the main reactants, ignition is suppressed. It is concluded that NOCl acts as a sensitizer only in so far as it is decomposed to form the true sensitizer NO, and that NOCl itself acts mainly as a chain terminator. A. SCHOFIELD

541.127 : 542.943

2007. Effect of pressure on the oxidation rate of copper at moderate temperatures. J. A. ALLEN. Letter in *Research*, **5**, 487–9 (*Oct.*, 1952).

It has been found that, at 127°C and for small thicknesses of the oxide film consisting of Cu_2O only, the law of the oxide film growth is parabolic for oxygen pressures $\geqslant 10$ mm Hg, and logarithmic for low pressures, e.g. 0·2 mm Hg. The average thickness of the Cu_2O layer (before CuO begins to appear) is in the range of 1100–1700 Å for electrolytically polished surfaces. F. LACHMAN

541.128

2008. The effect of specific catalysts on the reactions of the steam-carbon system. F. J. LONG AND K. W. SYKES. *Proc. Roy. Soc. A*, **215**, 100–10 (*Nov.* 6, 1952).

The reactions of the steam-carbon system have been studied by the static method at 750°C using extracted coconut charcoal to which Fe, Na, Ca and Al were added separately. The steam-carbon reaction is catalysed chiefly by Na, the CO_2–C reaction by Fe and Na, while the heterogeneous oxidation of CO by steam is enhanced by all the additions except Al. As required by the electronic theory of catalysis, the general course of the gasification of the C is found to be unaltered. Side reactions of the gases with the additions tend, however, to obscure changes in the rates of the individual steps, but give useful information about the composition of the catalysts under working conditions. The question of how the catalysts for the oxidation of C fulfil the role assigned to them by the electronic theory is discussed in the light of these results. An explanation is suggested in

terms of the probable non-stoichiometric character of the atomic layers in closest contact with the C. A.

541.128

2009. The catalysis of the carbon monoxide-steam reaction. F. J. Long and K. W. Sykes. *Proc. Roy. Soc. A*, **215**, 111–19 (*Nov.* 6, 1952).

The kinetics of the CO-steam reaction occurring heterogeneously at the surface of coconut charcoal have been determined under comparable conditions both before and after the extraction of the metallic impurities. Measurements have been made by the flow method in the temperature range 724 to 823°C at pressures of the gases from 3 to 760 mm. The impurities are found not only to catalyse the reaction very markedly, but also to alter its general kinetic relationships. The order with respect to CO is raised from almost zero to nearly unity while that with respect to steam is correspondingly lowered; a slight retardation by H is also introduced. Qualitatively different reaction paths are therefore thought to be followed in the presence and in the absence of the impurities. The results for the extracted charcoal can be explained by supposing the active sites to be surface C atoms more firmly bound to the rest of the lattice than those attacked during gasification of the carbon by steam or CO_2. On the original charcoal a much more reactive surface for the oxidation of CO by steam is provided by the metallic oxides. Present knowledge of the chemistry of such surfaces supports this view and suggests the probable reaction mechanism. A.

ELECTROCHEMISTRY 541.13

541.132.3 : 575.16

2010. Ionization, pH and biological activity. H. C. S. Wood. *Nature* [*London*] **170**, 994–6 (*Dec.* 13, 1952).

Small changes in the pH of a solution may produce large changes in the degree of ionization of a drug; this as well as ionization of the receptor, within or without a cell, may have profound effects on biological response. Accurate knowledge of ionization constants of biological substances is therefore desirable.

J. JACOBS

541.133.1

2011. Ionic mobility at grain boundaries. P. E. Goddard and F. Urbach. Letter in *J. chem. Phys.*, **20**, 1975 (*Dec.*, 1952).

A cast slab of silver bromide consisting of individual crystals (few mm size) is arranged between silver nitrate and potassium bromide solutions. With positive electrode in the nitrate electrolysis results in deposition of silver bromide on the potassium bromide side of the crystal slab, showing the dominant mobility of the silver ions. Close inspection shows that the ions migrate preferentially along grain boundaries. G. F. J. GARLICK

541.135 : 536.7

2012. Thermodynamics of irreversible electrochemical processes. P. H. Kemp. Letter in *Nature* [*London*] **170**, 1028 (*Dec.* 13, 1952).

A discussion of a recent paper by DeGroot and Tolhoek [Abstr. 8294 (1951)] leads to the conclusion that their second method of mathematical treatment must be considered invalid, while the result of the first treatment is that thermodynamic measurements on any system will never yield anything other than the electrochemical potentials of the ionic species concerned, in agreement with Guggenheim's original conclusions (1929, 1930). F. LACHMAN

541.135.5

2013. Existence of a discontinuity in the cathodic polarization of platinum in the electrolysis of dilute acid solutions. L.-H. Collet and M.-C. Pommier. *C.R. Acad. Sci.* [*Paris*] **235**, 1033–5 (*Nov.* 3, 1952) *In French.*

A method is described for the study of electrolysis, which depends on the limitation of diffusion phenomena by reducing the duration of polarization as far as is consistent with the attainment of saturation at a given current density. When the method is applied to the case of polarization of Pt in aqueous solutions of HCl (or H_2SO_4), a discontinuity is revealed between the concentrations N/2000 and N/2222. This does not occur for Ag and Cu. There are 2 illustrative curves. H. H. HODGSON

541.135.5

2014. Charge-free electrodes in electrochemistry. H. Oel and H. Strehlow. Note in *Naturwissenschaften*, **39**, *No.* 20, 478 (1952) *In German.*

The two positions of zero potential, viz. that of Lippmann (1947) and Billiter (1930), for Hg against the normal hydrogen electrode, are interpreted as due to varying polarizability of Hg within the particular potential range. H. H. HODGSON

541.135.5 : 621.317.32

2015. A method for measuring the potential of a current-carrying electrode. A. G. Milligan. *Brit. J. appl. Phys.*, **3**, 372 (*Dec.*, 1952).

Measurement of the potential of a current-carrying electrode is subject to error when the capillary of the reference electrode is situated in the path of the current through the electrolyte. This error can be avoided by siting the reference electrode behind a pin-hole through the main electrode, provided that no current flows through the hole. The method also permits the use of a reference electrode of moderate dimensions inserted directly into the cell electrolyte. A.

541.138 : 620.193

2016. Fundamental energy principles of corrosion. E. Lange. *Schweiz Arch. angew. Wiss. Tech.*, **18**, 395–404 (*Dec.*, 1952) *In German.*

Deals with: (1) Problems of corrosion research, especially those involving fundamental energy principles; (2) the dual nature of every ion as a chemical and electrical individual in a single phase; chemical potential;(3) electrical potential of the phase, electrochemical and actual potential, importance of electrochemical fall of potential, the energetics of the single electrode with one electrode reaction; (4) energetics of a double electrode, local current fall, external current fall; (5) energetics of a simple corrosion system: metal/metallic oxide/oxygen as second electrode; (6) energetics and kinetics of a moist corrosion system with practically pure electron conductivity, or with practically pure ionic conductivity, the intermediate layer; (7) complex cases of corrosion. Five diagrams and 22 references. H. H. HODGSON

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

2017. The photolysis of solid potassium azide. P. W. M. Jacobs and F. C. Tompkins. *Proc. Roy. Soc. A*, **215**, 254–65 (*Nov.* 25, 1952).

Experimental measurements of photoconductance in K and Ba azides and of the kinetics of photolysis of the K salt are reported. The theory previously advanced [Abstr. 1278 (1952)] to explain the photodecomposition of Ba azide is confirmed and extended by a calculation of the probable lifetime of a trapped exciton. Ionic conductance measurements enable the exciton traps to be identified with vacant cation sites and it is pointed out that the thermal activation energy required for the decomposition of the double trapped excitons is governed by steric considerations. A.

541.14 : 534.23

2018. Relations between the wavelength and the oxidation of potassium iodide by ultrasonics. R.-G. Busnel and D. Picard. *C.R. Acad. Sci.* [*Paris*] **235**, 1217–20 (*Nov.* 17, 1952) *In French.*

The piezoelectric quartz generators are controlled at spot frequencies in the range 192–960 kc/s by a h.f. oscillator. The weight of iodine liberated is plotted as a function of the h.f. voltage and of the h.f. output intensity at the different spot frequencies. The relation between electrical and acoustical power developed by the crystal is established experimentally, and enables the weight of iodine liberated by a constant acoustical power to be determined as a function of the wavelength. For fixed acoustical powers ranging from 30 to 90 W, the weight liberated attains a single maximum in the region of 300 kc/s and appears to be independent of frequency in the range 400–1000 kc/s. H. H. GREENWOOD

541.14 : 535.343

2019. On photochemical sensitization. W. Martienssen and R. W. Pohl. *Z. Phys.*, **133**, *No.* 1–2, 153–7 (1952) *In German.*

KBr crystals sensitized by a very small proportion of KH develop an absorption near 2200 Å (*U* band). X-rays reduce the intensity of this band in crystals irradiated at −183°C, and produce other bands corresponding to those produced in unsensitized KBr, chiefly the *F*-band near 6000 Å and the α-band near 2000 Å. On warming to 20°C the *F*-centres are much more stable in the sensitized than in the unsensitized crystals. From the mechanism of these changes it is shown that there must be a close connection between the extension to longer wavelengths of the photochemically active spectrum by sensitization, and the stabilization of the photochemical reaction products. S. T. HENDERSON

541.14 : 535.89

2020. New high light-intensity apparatus for photochemical reactions. E. Krautz. *Abhandl. Braunschw. Wiss. Gesell*, **4**, 5–11 (1952) *In German.*

Apparatus for photochemical reactions of substances with active absorption especially in the short wavelength region of the ultraviolet spectrum is described. As light sources, water-cooled high pressure mercury lamps and new xenon arc lamps are used. The water-cooled annular cylindrical vessels containing the photochemical substances are made of fused quartz or special glasses with u.v. transmission. They completely surround the light sources, which can be exchanged very easily. In this way energy losses of u.v. radiation and heating of the photochemical substances are avoided, so that best efficiencies can be quickly reached. A.

541.14 : 542.943

2021. The mercury photosensitized oxidation of paraffins. B. deB. Darwent. Letter in *J. chem. Phys.*, **20**, 1979–80 (*Dec.*, 1952).

The reaction has been assumed to occur through the photosensitized decomposition of the paraffin. Inspection of the quenching cross-sections for the appropriate wavelength indicates that in fact, of the total quenching, 93% may be attributed to quenching by oxygen and 7% by ethane. An even smaller proportion may be expected for quenching by methane. H. H. GREENWOOD

541.15

2022. Cross-linking of polythene by pile radiation. A. Charlesby. *Proc. Roy. Soc. A*, **215**, 187–214 (*Nov.* 25, 1952).

Polythene subjected to irradiation in the Harwell B.E.P.O. pile becomes cross-linked, and a new type of plastic is produced which does not melt at about 115°C, nor dissolve in hot organic compounds. The mechanical properties are also altered, especially above 115°C, when the plastic shows rubber-like elasticity. The paper is mainly confined to a study of the relationship between the degree of cross-linking and the amount of incident radiation causing cross-linking. Possible mechanisms of cross-linking are briefly considered. Cross-linking is shown to arise primarily from the fracture of C–H bonds, and the liberation of hydrogen. The weight changes ΔM of a specimen of weight M, and surface area A, subjected to radiation R is found to be represented by the equation $\Delta M = -\alpha_1 MR + \alpha_2 MR^2 + \beta_1 AR^2 - \beta_2 AR^2$. These terms are considered to arise from hydrogen evolution from the bulk of the polymer, methane, ethane, etc., evolution from near the surface, and surface oxidation. From the hydrogen-loss term α_1 the efficiency of cross-linking is deduced as 1% of carbons cross-linked per unit radiation defined as 10^{17} thermal neutrons/cm², and the associated fast neutrons and gammas. Microchemical analysis reveals a reduction in H/C ratio with radiation. The cross-linking ratio deduced is 1·1% of carbon cross-linked per unit radiation. The corresponding figure deduced from the amount of radiation required to render cross-linked polythene insoluble is 1·1 to 1·4%. For paraffin wax the figure is 0·9%. From the volume of gas evolved a value of 1·16% is obtained. The effects of different forms of radiation are considered. It is concluded that γ-radiation as well as fast and thermal neutrons are responsible. The energy required to break a C–H bond is found to be of the order of 25 eV. The value of this physical method of producing cross-linking in polythene and in other long-chain polymers under accurately

controllable conditions, without the incorporation of other chemical compounds and without heat treatment, is discussed. Since the mechanism of polymerization is different, a range of new polymers can be envisaged, of which the physical properties can be studied as a function of the degree of cross-linking. A.

541.15

2023. An after-effect in butter-fat irradiated with high-energy electrons. R. S. HANNAN AND H. J. SHEPHERD. Letter in *Nature* [*London*] **170,** 1021–2 (*Dec.* 13, 1952). See also Abstr. 3978 (1952).

541.15

2024. Irradiation of linear high polymers. K. LITTLE. Letter in *Nature* [*London*] **170,** 1075–6 (*Dec.* 20, 1952).

A preliminary account of chemical and physical changes which take place in linear high polymers (e.g. polyamides, polyethylenes, nucleic acids) when they are exposed to radiation in the Harwell pile or to electrons from a Van de Graaff generator, the results being followed mainly by X-ray diffraction.

C. B. ALLSOPP

541.15 : 539.166.08

2025. Chemical dosimetry of gamma rays in the presence of slow neutrons. M. CORVAL, A. CHAPIRO AND C. COUSIN. *C.R. Acad. Sci.* [*Paris*] **235,** 799–800 (*Oct.* 13, 1952) *In French.*

In the presence of slow neutrons (e.g. in the Chatillon pile), γ-ray dosage can be measured by observing the difference between the chemical effects of the mixed radiations on an organic compound containing C, H and O only and its "heavy" variant containing C, D and O, 1·1-diphenyl-2-picryl-hydracyl being used as a radical indicator. The systems methanol : methanol [D] and methyl acetate : methyl acetate [D] have been used satisfactorily.

C. B. ALLSOPP

DISPERSIONS . COLLOIDS . ADSORPTION
541.18

541.18 : 530.162

2026. On Verwey–Overbeek's theory of the interaction force between two colloidal particles. Y. IKEDA. *J. Phys. Soc. Japan,* **8,** 49–54 (*Jan.–Feb.,* 1953).

The expression of the free energy obtained by using V.–O's. first method is given in a strictly statistical mechanical way; no correction is necessary such as Levine [Abstr. 2136 (1951)] proposed. Two new correction terms are added to V.–O's. formulae obtained by their second method. One of them is added to cancel the effect that charges still remain on the particle surface when the surface potential is kept constant and the charges of ions vanish. The other is added when the adsorbed ions on the surfaces are kept fixed and the charges of ions vanish, to cancel the effect that the concentrations of ions between two parallel plates are different from the normal concentrations at infinite distance from the plates. A.

541.18.041.3

2027. The swelling and aggregation of colloid particles during the sol–gel transition. P. K. KATTI. Letter in *J. chem. Phys.,* **20,** 1980–1 (*Dec.,* 1952).

Measurements of the depolarizations of transversely scattered light provide data related to the size and shape of colloid particles. If the intensity I_z of the transversely scattered light with incident vertically polarized light and the corresponding depolarization P_v are known then the density scattering I_d is given by $I_d = I_z(3 - 4P_v/3 + 3P_v)$. The existence of a maximum on the I_d/time curve indicates an increase in size of particle by aggregation. Various sol–gel transitions are studied in this way, and it is shown that the transition of lyophilic gels proceeds in three stages: (1) particles increase in size by developing a cloud of water molecules; (2) particles swell by solvent molecules entering structure of particle; (3) particles grow by aggregation. J. IBALL

541.182.2

2028. Influence of the ratio of the flow of air and of liquid on the fineness of micromists. R. BOUCHER. *C.R. Acad. Sci.* [*Paris*] **235,** 1188–90 (*Nov.* 17, 1952) *In French.*

It is shown that for a certain ratio of flow of air to that of liquid, the fineness of the suspension may be inversely proportional to the air pressure. T. C. TOYE

541.182.6 : 534.23

2029. Resuspension of Dow latex '580G' by ultrasonics. P. HATFIELD, H. W. EMERTON AND P. E. WRIST. Letter in *Nature* [*London*] **170,** 797–8 (*Nov.* 8, 1952).

Attempts at resuspension of Dow polystrene latex "580G," which had dried out from a 40% suspension, by the application of ultrasonics have proved successful, the main conditions necessary being: (*a*) Low concentration of solid in liquid; (*b*) Short period of ultrasonic treatment; < 2 min.; (*c*) Soft tap water.

T. C. TOYE

541.183

2030. The kinetics of adsorption at liquid surfaces. K. L. SUTHERLAND. *Austral. J. sci. Res. A,* **5,** 683–96 (*Dec.,* 1952).

It is shown that convection currents govern the time rate of fall of surface tension of aqueous solutions when measurements are made in the usual way. The complete interpretation of such data is not possible at present so that an experimental method is suggested whereby data may be obtained which could be interpreted. The mathematical equations are given for this method. A.

541.183

2031. The dynamical character of adsorption. J. H. DE BOER. *Oxford, Clarendon Press* (1953) 256 *pp.*

"Attempts to create a picture of an adsorbed layer of gas, and describes the motions of molecules adsorbed on a surface and their interaction with it. The conception of a two-dimensional van der Waals's gas is used throughout, and the consequences of the picture are discussed in a way that the student can grasp and memorize."

541.183 : 539.11

2032. Some investigations in the field of the theory of solids. V. Adsorption. Surface states. T. A. HOFFMANN. *Acta phys. Hungar.*, **2**, *No.* 3, 195–208 (1952).

For Pt IV, see Abstr. 1798 (1953). The surface properties of a solid, such as adsorption, surface states, behaviour of the contact between two solids, etc., can be treated with the quantumchemical method used in the previous Pts. These properties can be dealt with as linear (one dimensional) problems in a good approximation, considering the crystal block as built up of parallel chains, each showing the required properties at its end. The interaction between the various chains does not affect the surface (i.e. end-) properties greatly and thus the method can act as a valuable guide in the surface-phenomena of three-dimensional crystals. In the present paper the effects of a single-atom layer are treated. A.

CHEMICAL STRUCTURE 541.2/.6

541.24 : 535.43

2033. Molecular weight of potato amylopectin as determined by light scattering. L. P. WITNAUER, F. R. SENTI AND M. D. STERN. Letter in *J. chem. Phys.*, **20**, 1978–9 (*Dec.*, 1952).

Light scattering measurements were made on aqueous solutions of amylopectin and on acetylated amylopectin in several organic solvents. Various concentrations, wavelengths and temperatures were studied. The results are consistent with a molecular weight of 10 million and it is believed that molecules of this size exist in starch granules. J. IBALL

541.57

2034. The geometrical classification of chemical bonds. Geometrical definition of chemical functions. R. DAUDEL. *C.R. Acad. Sci.* [*Paris*] **235**, 1035–6 (*Nov.* 10, 1952) *In French.*

541.57

2035. Conditions for the formation of hydrogen bonds. W. S. FYFE. *J. chem. Phys.*, **21**, 2–4 (*Jan.*, 1953).

The conditions necessary for the formation of H bonds are suggested to be asymmetry of non-bonding electron pairs and small size of H bonded atoms. Conditions for symmetry of such bonds are discussed. A.

541.57 : 535.343—15

Infrared spectroscopy and the character of chemical bonding. *See Abstr.* 1511

541.64 : 539.374 : 539.217

Viscosity, self-diffusion and allied effects in solid polymers. *See Abstr.* 1963

LABORATORY APPARATUS 542.1/.7

542.1

2036. Apparatus for controlled atmosphere research. G. R. THOMAS AND N. N. LICHTIN. *Rev. sci. Instrum.* **23**, 738–40 (*Dec.*, 1952).

The handling of atmosphere-sensitive substances usually requires a special technique for each case. These techniques often involve difficultly constructed and specific apparatus which will be used only once. It is the purpose of this paper to present a controlled atmosphere laboratory which will give a general solution to such problems. A.

542.61

2037. Phase separation of solutions of polymethylacrylic esters. II. E. JENCKEL AND J. DELAHAYE. *Z. Naturforsch.*, **7a**, 682–92 (*Oct.*, 1952) *In German.*

See Abstr. 3174 (1951). Solubility curves are given for a number of fractions of polymethylacrylic acid esters, of polymerization degree 500 to 30 000, in *p*-cymol, *n*-propanol and *n*-butanol. The coordinates of the critical solution point are thermodynamically evaluated, employing Miller's expression for the mixture entropy of athermal solutions in combination with a quadratic term ux_2^2 for the heat of solution, and the additional entropy of irregular solution to be inserted in the equation $\mu = \alpha + \beta/T$.

H. H. HODGSON

CHEMICAL ANALYSIS 543/545

545.7

2038. A method of gas analysis based on optical and acoustical phenomena. V. N. ERSHOV. *Zh. tekh. Fiz.*, **22**, *No.* 6, 1022–8 (1952) *In Russian.*

The method described was suggested by M. L. Veingerov in 1938 and is based on measurements of the energy of acoustic oscillations set up in the gas and converted into electric current, this being an appropriate test method for many technological processes on which process control apparatus may be based. The calibration curve of the apparatus depends on the spectral characteristic of the material of the windows transmitting the radiation, the thickness of the irradiated gas layer, the concentration of the absorbing component in the absorption chamber, the temperature of the radiator and on the reflection characteristic of the walls of the absorption tube. The radiation used is a practically parallel beam of i.r. light, the emitter an electrically heated silite plate. To avoid the Bell effect, the membrane used as transducer must not be irradiated. The windows of the rotating disk producing the intermittence of the radiation may consist of quartz, glass, NaCl or the like. B. F. KRAUS

545.8 : 553.1

2039. Quantitative interpretation of differential thermal analysis. J.-L. SOULÉ. *J. Phys. Radium*, **13**, 516–20 (*Nov.*, 1952) *In French.*

Two methods of interpretation are discussed: (1) it is shown that the area of the peak portion is proportional to the mass of the reacting mineral contained in the crucible, and a formula is proposed; (2) when the height of the peak is utilized, it is necessary to compare specimens with the same crystalline structure. The choice of the method will depend upon the concrete characteristics of each case.

F. LACHMAN

545.823

2040. Ultra-violet papyrography: an automatic analytical apparatus using filter paper without a colour reagent. Y. HASHIMOTO AND I. MORI. Letter in *Nature* [*London*] **170,** 1024–5 (*Dec.* 13, 1952).

Light of 2537 Å is passed through the paper and the transmission registered by a photomultiplier. The method is suitable for (1) densitometry of finished filter papers prepared by paper chromatography or electromigration; (2) automatic paper chromatography; (3) automatic paper electromigration; (4) automatic paper electrochromatography. S. J. GREGG

CRYSTALLOGRAPHY 548

548.5

2041. Two dimensional diffusion phenomena in crystal growth from solution. F. S. A. SULTAN. *Phil. Mag.*, **43,** 1099–1106 (*Oct.*, 1952).

Multiple-beam white light fringes of equal chromatic order are used for the study of the growth from solution of sodium chlorate. They are sharper and much more informative than monochromatic Fizeau fringes, and have proved to be very sensitive for the measurement of variation of concentration. The experimental results are found to be in agreement with the assumption of the existence of the quasi-stationary state theory introduced by Rieck and further developed recently by Franck. According to this theory, the radial gradient of concentration is analogous to a static potential field multiplied by a Gaussian cut-off factor. The law relating the concentration to the radius is found to be of logarithmic form near the crystal and exponential at larger distances. A.

548.5

2042. Enclosure of sodium during crystallization of potassium nitrate with radioactive sodium as indicator. J. PAULY. *C.R. Acad. Sci.* [*Paris*] **235,** 1215–17 (*Nov.* 17, 1952) *In French.*

See also Abstr. 8553 (1952). In spite of the difference in ionic radii some sodium is enclosed, if potassium nitrate crystallizes out of a solution containing sodium ions. The amount is measured with radioactive sodium: Na^{22} is used in weak solutions (obtained from Mg^{24} in the cyclotron) and Na^{24} in strong solutions (obtained by bombarding Na with neutrons). It is found that the inner parts of the crystals contain Na homogeneously, whilst the outer regions contain more. The amount in the inner parts is proportional to the Na concentration in the solution, the proportionality constant being $2{\cdot}1\times10^{-3}$. The process is exactly similar to that of Ce and Sr, but somewhat more is enclosed, although the amounts have the same order of magnitude. A. J. TAYLOR

548.5

2043. Oriented chemical growth on single crystals of zinc and cadmium. L. N. D. LUCAS. *Proc. Roy. Soc. A*, **215,** 162–74 (*Nov.* 25, 1952).

The oriented chemical growth of the oxides are studied on different surfaces of single crystals of Zn and Cd and also of the sulphide of Cd. The contact planes between substrate and oriented overgrowth were found by determining the facets upon which a particular orientation occurs. The orientation is found to depend on the type of facet, and hence on the surface topography of the substrate which could be determined in favourable cases. The clean surfaces of the metallic crystals used were prepared by electrolytic methods. The inner potentials of Zn and ZnO have been measured. A.

548.5

2044. The effect of mechanical deformation on the growth of cadmium iodide crystals from solution. A. KORNDORFFER, H. RAHBEK AND F. S. A. SULTAN. *Phil. Mag.*, **43,** 1301–6 (*Dec.*, 1952).

CdI_2 crystals growing in thin plates, have been subjected to mechanical deformation, by an indentation process. As a result of this deformation, the growth properties of the crystals are altered, and several other striking effects take place, which have not previously been observed. It is concluded from the experiments that the mechanical deformation is the vital factor for these growth effects to occur. Variation in concentration by disturbing the mother liquor has no effect. Slip processes, leading to the creation of dislocation or increase of dislocations already present in the crystal, may account for the spiral nature of the growth sometimes observed. A.

548.5

2045. Mechanism of growth of whiskers on cadmium. M. O. PEACH. Letter in *J. appl. Phys.*, **23,** 1401–3 (*Dec.*, 1952).

On the basis that each whisker contains a screw dislocation along its axis a qualitative explanation is given of why the whiskers are uniform in size, ¼–½in long, and about 1 μ dia., and why they occur on Cd and Sn. Three methods for retarding or preventing whisker growth are briefly mentioned. S. WEINTROUB

548.5

2046. A prismatic substructure formed during solidification of metals. J. W. RUTTER AND B. CHALMERS. *Canad. J. Phys.*, **31,** 15–39 (*Jan.*, 1953).

Single crystals of Sn grown from the melt under a wide range of conditions are shown to exhibit a fibrous structure which manifests itself as parallel ridges ("corrugations") on the free surface of the specimen and as a hexagonal network ("hexagonal cells") on the growing solid-liquid interface. The centre of each cell projects into the liquid. Segregation of impurities is shown to occur during solidification in a manner intimately related to the structure. The structure is suppressed by growth at low speeds or under a steep temperature gradient. The size and regularity of the elements of the structure depend upon speed of growth, temperature gradient and impurity content. A theory is advanced which accounts for the origin and observed properties of the structure. This theory shows that the structure consists essentially of a particular distribution of impurities resulting from non-equilibrium solidification. A.

548.5

2047. The preparation of single crystals and bicrystals by the controlled solidification of molten metals. B. CHALMERS. *Canad. J. Phys.*, **31**, 132–46 (*Jan.*, 1953).

An account is given of the methods that have been developed for the production of single crystals and bicrystals of a wide variety of metals by controlled freezing of the molten metal in a horizontal "boat." Orientations are controlled by a "seeding" technique. A detailed qualitative analysis is given of the factors associated with the presence of "stray" crystals. Their formation is discussed in terms of nucleation and in terms of their subsequent survival, and attention is drawn to the significance of purity, of speed of growth and of the temperature gradient in the liquid. A.

548.5

2048. Investigation of crystal growth by thermal etching and oriented overgrowth. A. SMAKULA AND M. W. KLEIN. *J. chem. Phys.*, **21**, 100–4 (*Jan.*, 1953).

Thermal etching of perfect thallium halide single crystals *in vacuo* takes place preferably at points where the crystal is distorted. The etching proceeds in regular steps forming pits bounded always by (110) planes. High temperature produces a disordered etching and marked surface striation. The formation of oriented hillocks indicates a surface migration of molecules. Crystal overgrowth from the vapour takes place on single points of the surface with preferably the same orientation as the substrate. The population distribution of microcrystals depends on the crystal orientation. The crystals, although grown at very low speed, show surface striations. A.

548.5 : 530.162

2049. Statistical mechanics and the partition of numbers. II. The form of crystal surfaces. H. N. V. TEMPERLEY. *Proc. Cambridge Phil. Soc.*, **48**, *Pt IV*, 683–97 (1952).

For Pt I, see Abstr. 739 (1950). The classical theory of partition of numbers is applied to the problem of determining the equilibrium profile of a simple cubic crystal. It is concluded that it may be thermodynamically profitable for the surface to be "saw-toothed" rather than flat, the extra entropy associated with such an arrangement compensating for the additional surface energy. For both a two- and a three-dimensional "saw-tooth" the extra entropy varies, to a first approximation, in the same way as the surface energy, i.e. is proportional to $N^{\frac{1}{2}}$ or $N^{\frac{2}{3}}$ respectively, where N is the number of molecules in a "tooth." For the simple cubic lattice, the entropy associated with the formation of a tooth containing N atoms is estimated to be $3 \cdot 3kN^{\frac{2}{3}}$. It is also possible to estimate the variation of the "equilibrium roughness" of a crystal with temperature, if its surface energy is known.

548.535

2050. Crystal distortion of graphite in cast irons. E. MATUYAMA. Letter in *Nature* [*London*] **170**, 1123–4 (*Dec.* 27, 1952).

The outer layers of graphite flakes from cast irons were removed, step-by-step, by an oxidizing agent and X-ray powder patterns were taken at various stages of the process. It is concluded that the crystal structure is more perfect in the region of the core of the grains where the crystals were first formed.

A. E. DE BARR

548.572

2051. On the anisotropic dissolution and the orientation of the phosphorescent dye, trypaflavin in the crystal of citric acid. D. YAMAMOTO. Letter in *J. chem. Phys.*, **20**, 1974–5 (*Dec.*, 1952).

Inclusion of trypaflavin influences a striking growth of the (101) and (110) faces of the rhombic citric acid crystal. The dye coloration does not appear in the (011), (0$\bar{1}$1), (01$\bar{1}$) and (0$\bar{1}\bar{1}$) faces. The phosphorescence is also anisotropic, being absent in the (011) and (01$\bar{1}$) directions of a flat specimen with faces in the *b*, *c* axial directions. Polarization measurements suggest that the dye molecule has its oscillator direction parallel to the *c* axis. G. F. J. GARLICK

548.574

2052. Screw dislocations, etch figures, and holes. F. H. HORN. *Phil. Mag.*, **43**, 1210–13 (*Nov.*, 1952).

Etch figures similar in appearance to those observed in the mineralogical technique are shown to result from the rapid chemical dissolution of growth spirals on silicon carbide. Each spiral resulting from an independent screw dislocation gives an etch figure. The etch figure produced by rapid dissolution, therefore, becomes a convenient means for indexing screw dislocations whether growth spirals are evidenced or not. Prolonged rapid dissolution of a crystal with a screw dislocation extending between opposite crystal faces results in a hole through the crystal at the site of the screw dislocation. A.

548.574

2053. The growth and orientation of single crystals of indium. A. J. GOSS AND E. V. VERNON. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 905–6 (*Nov.*, 1952).

Experiments show that the successful growth by slow solidification from the melt of single crystal rods, up to 15 cm long and 3 mm diameter, with orientations of 50–90°, depends on the purity of indium. It was necessary to electrolytically purify 99·9+% pure metal. After electropolishing, the crystals were chemically etched and the orientations determined by the optical etch-pit reflection method. A new chemical etchant is briefly described. A table of crystallographic angles of the indium structure is given. S. WEINTROUB

548.574

2054. A simple goniometric method for examining preferred orientation in etched metal polycrystals. P. DUNSMUIR. *Brit. J. appl. Phys.*, **4**, 27–9 (*Jan.*, 1953).

An etched metal specimen on the rotating stage of a microscope was directly illuminated by a 5 ft fluorescent tube having its axis parallel to that of the microscope. Reflections from crystal faces, with inclinations to the stage plane of up to 45°, could be plotted in azimuth, by rotating the stage until the given faces had the maximum brightness, and in altitude, by giving the tube different colours along its length or by obscuring part with a movable screen.

A. L. MACKAY

548.574 : 535.417

2055. Interferometric study of etch pits. R. Gevers, S. Amelinckx and W. Dekeyser. *Naturwissenschaften*, **39**, *No.* 19, 448–9 (1952).

Multiple beam interferometry etch figures on a topaz crystal are studied. The formation of etch channels is discussed in terms of a dislocation origin. Etched spirals and rectilinear arrays of etch pits on SiC are recorded and these are associated also with dislocation arrays. S. TOLANSKY

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

2056. The zero point energy and θ values of crystals. C. Domb and L. Salter. *Phil. Mag.*, **43**, 1083–9 (*Oct.*, 1952).

The calculations of Montroll of the moments of the frequency spectrum of a number of crystal lattices enable an accurate estimate to be made of the zero point energy of these lattices. It has been customary to use the value $\frac{9}{8}k\theta$, based on the Debye approximation, to estimate the zero point energy, and it is shown that this formula is only accurate if θ_∞, the limiting value of θ for high temperatures, is used. It is shown that θ_∞ can be simply expressed in terms of the force constants between atoms of the crystal. A.

548.7

2057. Electronic structure of the diamond crystal. F. Herman. Letter in *Phys. Rev.*, **88**, 1210–11 (*Dec.* 1, 1952).

The method of orthogonalized plane waves has been used to investigate the energy band structure of diamond and germanium. Some of the results for diamond differ from those obtained by previous investigators: (*a*) the three lowest conduction bands are degenerate at the central point of the Brillouin zone ($k = 000$); (*b*) of the four valence bands three are degenerate and have negative curvature at $k = 000$. These and other results, and the method of computation, are discussed. P. T. LANDSBERG

548.7

2058. Criticism, partial foundation and limits of application of the zonal theory of electrons in crystals. S. I. Pekar. *Zh. tekh. Fiz.*, **22**, *No.* 6, 1062–75 (1952) *In Russian.*

The zonal theory is an approximate estimate of the electron states in crystals, based on the following simplifying assumptions: (1) the quantum states of the electrons are calculated as though the nuclei of the atoms (ions) were rigidly fixed at the lattice nodes of the crystal. The electrons of the crystal are thus considered as a closed conservative system. The wave function of the electrons is independent of the co-ordinates of the nuclei, i.e. no correlation of the electron and nuclear movement is considered; (2) in the wave equation the potential energy of the electrons is replaced by the potential energy of the electrons in a certain external potential field. The latter is so chosen as to be equal to the mean field set up by all the electrons and nuclei in the crystal. After this replacement the electrons are no longer regarded as interacting and the multi-electron problem splits up into a number of comparatively simple single-electron problems. It is then possible to refer to energy and states of individual electrons moving in a periodical potential field. The energy spectrum of the electron consists of alternating permitted and prohibited energy zones. In the permitted zones the energy is an even analytical function of the wave vector k (3-dimensional continuous quantum number). The wave function of the system of electrons is the well-known antisymmetrical determinant built up of single-electron functions and the energy of the system is the sum of the electron energies. Points discussed: method of the self-consistent field; criticism of incorrect use of this method for the justification of the zonal theory; in what case have the self-consistent single-electron functions of the zonal theory a physical meaning; variant of the zonal theory based on the method of the self-consistent field; consideration of displacements of the atomic nuclei. B. F. KRAUS

548.7

2059. Ion radii and ion polarizability in rock salt lattices with ions with identical complete shells. E. Kordes. Note in *Naturwissenschaften*, **39**, *No.* 21, 488–9 (1952) *In German.*

The values for NaF, KCl, RbBr and α–CsI show that the ions are not distorted. The ratio of the + and − radii is 0·73 for all these. A table is given of calculated and empirical values which show good agreement. For MgO, CaS, SrSe and BaTe the ratio is also 0·73, but there is distortion. C. TURNER

548.7

2060. Electronic energy bands in metals. G. Parzen. *Phys. Rev.*, **89**, 237–43 (*Jan.* 1, 1953).

A method is presented for calculating the energy levels of a crystal. The method is based on finding a variational principle for the energy levels in terms of the Wannier functions instead of the usual Bloch wave functions. The variational principle does not give the energy $E(\mathbf{k})$ directly, but if $E(\mathbf{k})$ for a particular band is expanded in a Fourier series in $\mathbf{k}$, then the variational principle gives the Fourier coefficients of $E(\mathbf{k})$ in this expansion. The maxima and minima properties of the variational principle are investigated. The variational principle is properly modified for application to valence bands. The types of trial functions that will arise is discussed, and the method is applied to a one-dimensional crystal. Results are compared with the results of the method of orthogonal plane waves for the same problem. A.

548.7

2061. Color centers generated in sodium chloride by electrolysis. H. F. Ivey. Letter in *Phys. Rev.*, **88**, 1434 (*Dec.* 15, 1952).

548.7 : 535.343.2

2062. Colour centres in diamonds. P. Pringsheim and R. C. Voreck. *Z. Phys.*, **133**, *No.* 1–2, 2–8 (1952) *In German.*

Diamonds of types I and II are coloured by neutron bombardment and the coloration modified or reduced by subsequent heat treatment. A type I specimen

(transparent to 3200 Å) develops a strong absorption in the long u.v. region and a band at 6200 Å with little change in its i.r. absorption. A type II specimen (transparent to 2300 Å) develops an absorption band at 2830 Å and also the band at 6200 Å observed for type I. Successive neutron bombardment and heating of type II specimens produces a sharp absorption line at 5030 Å as observed by Dugdale [*A.E.R.E., Harwell report N/PC*-15 (1950)] but this does not occur in type I diamonds. G. F. J. GARLICK

548.7 : 539.23

The decomposition of thin oriented halide layers. *See Abstr.* 1966

548.7 : 539.32

2063. On the characteristic temperatures of single crystals and the dispersion of the "Debye heat waves." E. J. POST. *Canad. J. Phys.*, **31**, 112–19 (*Jan.*, 1953).

A procedure for the calculation of the number of normal modes of a single crystal is proposed which takes an intermediate position between the methods of Debye and Born–von Karman. The method of Debye is extended to an anisotropic continuum, where the cut-off and dispersion phenomena, which are due to the lattice structure, are accounted for in a semiempirical way. It appears possible to define a finite number of characteristic temperatures (one for cubic crystals and at most three for crystals of low symmetry) independent of direction. This ensures a comparatively simple calculation from the phenomenological elastic constants of the crystal, as such retaining one of the pleasing features of Debye's theory, i.e. a straightforward correlation between thermal and elastic data. The method is applied to 8 cubic monatomic crystals for which elastic data are available. The results provide some additional evidence to emphasize the significance of the dispersion of the Debye heat waves. An application to the hexagonal crystals of Cd and Zn leads to results similar to those obtained by Grüneisen and Goens who produced with these crystals the first experimental evidence of the dispersion phenomenon using the concept of a characteristic temperature dependent on direction. In the last section the correlation between the elastic constants of single crystals and the corresponding quasi-isotropic materials is discussed and illustrated with data found in the literature. It is shown that the polycrystalline state is more "elastic" (sometimes very considerably) than the single crystal state. The consequences of this "boundary layer elasticity" for the calculation of θ values are discussed. A.

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 1969–77

548.733

2064. Cameras for use with a fine focus X-ray tube. J. W. JEFFERY. *J. sci. Instrum.*, **29**, 385–8 (*Dec.*, 1952).

The small size of the focal spot of the Ehrenberg–Spear X-ray tube enables high resolution to be obtained with small cameras, and this, together with the small focus-window distance of 15 mm, shortens exposure times by the operation of the inverse square law. To take full advantage of this the specimen must be accurately defined and located. Powder cameras designed to achieve this are described. A.

548.733 : 537.531 : 621.386.1

2065. Fine-focus X-ray tubes and high-intensity monochromators. B. YA. PINES. *Izv. Akad. Nauk SSSR, Ser. fiz.*, **16**, *No.* 3, 333–8 (1952) *In Russian.*

The conditions for heat dissipation from a small focal spot are discussed as an introduction to a conference on high-intensity sources of X-rays (following abstracts) and current Soviet work is briefly reviewed. A. L. MACKAY

548.733 : 537.531 : 621.386.1

2066. A fine focus X-ray tube with regulated focal spot size. V. S. KOGAN AND B. YA. PINES. *Izv. Akad. Nauk SSSR, Ser. fiz.*, **16**, *No.* 3, 339–43 (1952) *In Russian.*

An X-ray tube has been constructed which gives resolved Cu $K\alpha$ doublets for all lines from a Cu wire specimen in a 57·4 mm dia. powder camera. At 50 kV it draws 0·5 mA and has a target loading of 5–8 kW/mm² with a focal spot area $<0{\cdot}005$ mm². The cathode assembly is earthed and the beam passes out through a 0·5 mm hole close to the hairpin filament leaving the anode normally. The latter is in the shape of a cone with semivertical angle 70° and is water-cooled. A. L. MACKAY

548.733 : 537.531 : 621.386.1

2067. A rapid (fine-focus) X-ray tube for back-reflection photographs and its application at normal and high temperatures. N. I. SANDLER. *Izv. Akad. Nauk SSSR, Ser. fiz.*, **16**, *No.* 3, 344–9 (1952) *In Russian.*

A fine focus X-ray tube (preceding abstract) has been slightly modified to carry a photographic plate and has been used to take back-reflection photographs from large metal specimens (1 cm²) enclosed in a vacuum container. The specimen can be heated under high vacuum to 1000°c with rotation in its own plane. With specimen-film distances of about 5 cm, exposures take 8–20 min. A. L. MACKAY

548.733 : 537.531 : 621.386.1

2068. The application of fine-focus X-ray tubes for impulse work. A. I. BUBLIK AND B. YA. PINES. *Izv. Akad. Nauk SSSR, Ser. fiz.*, **16**, *No.* 3, 350–4 (1952) *In Russian.*

Using a fine-focus tube [Abstr. 2066 (1953)] modified by the substitution of an enlarged cathode, back reflection photographs were obtained from metal specimens with single discharges of a 0·5 μF condenser. The specimen-film distance was about 5 cm. the focal spot about 0·6 mm² in area and the discharge passed in 30–50 msec. A. L. MACKAY

548.733 : 537.531 : 621.386.1

2069. An X-ray tube with an especially long and fine linear focus and certain of its applications. A. I. BUBLIK AND B. YA. PINES. *Izv. Akad. Nauk SSSR, Ser. fiz.*, **16**, *No.* 3, 355–9 (1952) *In Russian.*

An X-ray tube with a focal spot $22\times0{\cdot}3$ mm has been constructed. The beam emerges normal to the anode which is a wedge of angle 140° through a window in the cathode surface only 12 mm from the anode. Oscillation photographs can be taken without

motion of the crystal specimen which can be exceptionally small. For crystals with linear dimensions of about 0·05 mm exposures take 15–30 min.

A. L. MACKAY

548.733 : 537.531 : 621.386.1

2070. Apparatus for X-ray structural analysis using high intensity sources. I. E. DUDAVSKIĬ. *Izv. Akad. Nauk SSSR, Ser. fiz.*, **16**, *No.* 3, 360–6 (1952) *In Russian.*

An X-ray tube has been constructed in which focusing of the electron beam occurs in the field between the conical anode surface (semivertical angle 70°) and a parallel conical cathode surface. The filament is a fine hairpin situated in a small hole at the apex of the cathode cone. The electron beam passes through a fine hole at the apex of the anode cone and continues along a tube for several centimetres before striking the target surface normal to it. A wide variety of cameras are designed to fit round the tube and can be arranged for use under focusing, semi-focusing or non-focusing conditions for various types of specimens and ranges of Bragg angle. The tube takes 1 mA and gives a focal spot size of 0·03 × 0·20 mm.

A. L. MACKAY

548.733 : 537.531

2071. Back-reflection high-intensity beam camera for back-reflection photographs with a fine-focus tube. F. I. CHUPRININ. *Izv. Akad. Nauk SSSR, Ser. fiz.*, **16**, *No.* 3, 367–71 (1952) *In Russian.*

A flexible back-reflection camera has been made for use with Dudavskii's fine-focus X-ray tube (preceding abstract). The specimen-film distance is adjustable and provision is made for oscillating the film holder about its centre.

A. L. MACKAY

548.733 : 537.531

2072. Camera-monochromator for photographs of polycrystals (KMSP). S. S. KVITKA, E. V. KOLONTSOVA AND M. M. UMANSKIĬ. *Izv. Akad. Nauk SSSR, Ser. fiz.*, **16**, *No.* 3, 372–84 (1952) *In Russian.*

A cylindrical enclosure, about 30 cm in dia. and 3 cm thick has been fixed rigidly to a fine-focus X-ray tube. The enclosure can be evacuated and contains a bent-crystal monochromator permanently set to bring the beam to a focus about 7 cm inside the cylinder. Focusing cameras in several sizes, with extended powder specimens, and either of the low-angle transmission or high-angle reflection types can be fitted inside.

A. L. MACKAY

548.733 : 537.542

2073. A counter tube arrangement for X-ray measurements. R. BERTHOLD AND A. TROST. *Schweiz. Arch. angew. Wiss. Tech.*, **9**, 277–82 (*Sept.*, 1952) *In German.*

Describes Geiger counter techniques for X-ray crystallography. Typical plots of spectra are given, including data for SnO_2 taken at 30 kV (Cu anode tube). Details of a goniometer device are also included.

J. D. CRAGGS

548.734

2074. Determination of lattice disorientations by diffraction of X-rays transmitted through monocrystals. H. LAMBOT AND L. VASSAMILLET. *C.R. Acad. Sci. [Paris]* **235**, 1136–8 (*Nov.* 10, 1952) *In French.*

Bragg reflections of monochromatic X-rays are recorded at distances of 1–2 m from the specimen. These show disorientations in all crystals studied.

A. R. STOKES

548.734

2075. Some properties of lines on divergent-beam X-ray photographs. A. G. PEACE AND G. E. PRINGLE. *Phil. Mag.*, **43**, 1227–42 (*Dec.*, 1952).

The quantitative aspect of X-ray extinction is reconsidered in its particular relation to divergent-beam photography. Special consideration is given to the optical resolution obtainable with the usual experimental arrangements and some experimental data on unresolved lines are discussed. This leads to a determination of the mosaic spread of crystals previously conditioned by liquid air treatment to minimize primary extinction effects, but in general quantitative conclusions are hampered by the usual doubt as to how much of the observed extinction is primary and how much secondary.

A.

548.735

2076. On the deformation and polygonization of aluminium single crystals. H. LAMBOT AND L. VASSAMILLET. *C.R. Acad. Sci. [Paris]* **235**, 1232–4 (*Nov.* 17, 1952) *In French.*

The method described in Abstr. 2074 (1953) was used to investigate lattice deformation in single crystals after extensions ranging up to 10% and various heat treatments.

A. R. STOKES

548.735.44

2077. On the Fourier methods of interferometrical structure investigations. H. VIERVOLL. *Skr. Norske Vidensk. Akad. Oslo, Kl I* (**1950**) *Paper* 2, 65 *pp.*

A theoretical discussion. The basic principles of structure determination by X-ray and electron diffraction are summarized. For any given structure one can define an "ideal" electron density function Patterson function and radial distribution function. From X-ray or electron diffraction measurements one obtains a corresponding "distorted" function which differs from the ideal function owing to the termination of the Fourier series, thermal-motion effects, etc. The distorted function may be calculated from the ideal function of a known structure, and the relation between distorted and ideal functions is discussed. It is shown that the peaks in the radial distribution function $D(r)$ do not represent the interatomic distances as accurately as the peaks in $r.D(r)$. The determination of structure of molecules of a gas is also discussed. It is shown that false peaks may occur in the electron-density functions of single atoms as obtained experimentally by Fourier-transform methods.

A. R. STOKES

548.736.1

2078. On the structure of layers of magnesium, zinc and cadmium, produced by the condensation of molecular beams. N. T. MELNIKOVA, E. D. SHCHUKIN AND M. M. UMANSKIĬ. *Zh. eksper. teor. Fiz.*, **22**, *No.* 6, 775–9 (1952) *In Russian.*

X-ray analysis shows that the crystals produced by a molecular beam condensing on a surface have

parallel orientations with the hexad axis in the plane of incidence of the beam but making a greater angle with the normal than the angle of incidence. Curves of this angle are given for all three metals for an uncooled surface and for a surface cooled to −70°C.
J. M. HOUGH

548.736.3

2079. A series of structurally interrelated molybdenum and molybdenum tungsten oxides Me_nO_{3n-1}. A. MAGNÉLI. Letter in *Research*, **5**, 394–5 (*Aug.*, 1952).

Oxides Mo_8O_{23} and Mo_9O_{26} are known [Magnéli, *Acta chem. Scand.*, **2**, 501 (1948)], consisting of linked MoO_6 octahedra. The linkage is of the ReO_3 type and regular in two directions in the crystal, but in a third there is an irregularity, resulting in the omission of an O atom, at every eighth or ninth octahedron respectively. No further Mo oxides built on this principle have been found, but many of the type $(Mo, W)_nO_{3n-1}$ appear to exist; those with $n = 10$ and 11 have been confined by unit-cell and structure determinations.
A. J. C. WILSON

548.736.3

2080. On the superlattice formation in ternary alloys. S. MATSUDA. *J. Phys. Soc. Japan*, **8**, 20–5 (*Jan.–Feb.*, 1953).

The superlattice formations with body centred cubic lattice are discussed by taking into account the interactions between nearest neighbouring atoms as well as those between next nearest neighbouring atoms. On the basis of this theory the possibility of the various types of superlattice formations in ternary alloys is inferred. The experimental data on the superlattice formation in Cu–Mn–Al system are discussed from this point of view.
A.

548.736.4

2081. A superstructure in spinels. P. B. BRAUN. Letter in *Nature* [*London*] **170**, 1123 (*Dec.* 27, 1952).

$LiFe_5O_8$ has nearly a spinel structure, with an ordered arrangement of Li^+ ions below 735°C, partial order up to 755°C, and no order above this temperature. $LiAl_5O_8$ and γ–Fe_2O_3 show similar structures.
A. R. STOKES

548.736.4 : 537.226.2

A static model of $BaTiO_3$ at room temperature. *See Abstr.* 1617

548.736.5

2082. The structure of Bi_2NbO_5F and isomorphous compounds. B. AURIVILLIUS. *Ark. Kemi*, **5**, *Paper* 4, 39–47 (1952).

Tetragonal, $I4/mmm$, $a = 3{\cdot}835$, $3{\cdot}829$, $3{\cdot}802$, $c = 16{\cdot}63$, $16{\cdot}64$, $16{\cdot}33 \pm 0{\cdot}1\%$ for Bi_2NbO_5F, Bi_2TaO_5F, $Bi_2TiO_4F_2$ respectively, $Z = 2$. From intensities (Weissenberg and powder photographs, CrK radiation) Bi is in 4(*e*) with $z = 0{\cdot}325 \pm 1$, Nb in 2(*a*); from packing considerations O and F are distributed over 4(*c*), 4(*e*) with $z = 0{\cdot}12 \pm 1$, and 4(*d*). Only Bi_2NbO_5F was investigated in detail, but the others are isotypic.
A. J. C. WILSON

548.736.5 : 538.222 : 536.21

Physical properties of chromium alums at low temperatures. *See Abstr.* 1573

548.736.6

2083. The crystal structure of dioptase. N. V. BELOV, V. P. BUTUZOV AND N. I. GOLOVASTIKOV. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 6, 953–6 (1952) *In Russian.*

The structure of dioptase, of which a preliminary account was given [*Dokl. Akad. Nauk SSSR*, **37**, 156 (1942)] is now described in detail. The constitutional formula for the rhombohedral cell contents is $Cu_6(Si_6O_{18}).6H_2O$ and all atoms are in general positions with hexagonal cell parameters (x, y, z) as follows: Cu, (0·260, 0·335, 0·570); Si, (0·177, 0·233, −0·030); O_I, (0·182, 0·128, −0·010); O_{II}, (0·227, 0·318, −0·130); O_{III}, (0·219, 0·286, 0·180); H_2O, (0·115, 0·195, 0·585). The anions are Si_6O_{18} rings as in beryl.
A. L. MACKAY

548.737

2084. X-ray analysis of proteins. W. L. BRAGG. *Proc. Phys. Soc.* [*London*] *B*, **65**, 833–46 (*Nov.*, 1952).

It was shown in Bernal's work that a protein molecule of a given type is a structure with a definite individual form. The molecules are, however, of great complexity. X-ray analysis has passed from simple substances like rock salt to molecules with about one hundred atoms, and is now trying to analyse a molecule such as haemoglobin, which contains ten thousand atoms. The determination of any one protein would undoubtedly throw light on the character of these bodies, the basis of living matter. The work on haemoglobin in Cambridge under Dr. Perutz is described. Considerable advances have been made recently.
A.

548.737

2085. The cut-off phenomena of protein crystallography. A. D. BOOTH. *J. chem. Phys.*, **20**, 1907–10 (*Dec.*, 1952).

The well-known paucity of experimentally observed reflections obtained from X-ray studies of protein single crystals, and their tendency to occur in well marked spherical shells of reciprocal space, are examined quantitatively. It is shown that, in the case of one protein for which data is available, a simple model with no assumed internal structure gives adequate agreement with experiment. The addition of simple detail, such as nearest neighbour minimum approach distances, leads to further relations which could be used to produce improved agreement if required.
A.

548.737

2086. X-ray evidence for metal-to-metal bonds in cupric and chromous acetate. J. N. VAN NIEKIRK AND F. R. L. SCHOENING. Letter in *Nature* [*London*] **171**, 36–7 (*Jan.* 3, 1953).

The structure of cupric acetate has been determined: it is found that each copper atom forms four covalent bonds with oxygens and also a bond with another copper atom. Chromous acetate is most probably an isotype.
A. R. STOKES

548.737

2087. Crystal structure and lattice energy of orthorhombic hexachloroethane. Y. SASADA AND M. ATOJI. *J. chem. Phys.*, **21**, 145–52 (*Jan.*, 1953).

As a part of an investigation of the crystal structures

of hexachloroethane, the orthorhombic phase of hexachloroethane has been investigated by X-ray methods. The unit cell, of dimensions $a = 11{\cdot}56$Å, $b = 10{\cdot}18$Å and $c = 6{\cdot}42$Å, contains four molecules. The space group is $D_{2h}^{16} - Pnma$. The two- and three-dimensional Fourier series were calculated and atomic coordinates determined. Detailed discussions have been given for the lattice energy and molecular interaction of this crystal. A.

548.74

2088. An electron diffraction camera with a rotating sector. T. Ino. *J. Phys. Soc. Japan*, **8**, 92–8 (*Jan.–Feb.*, 1953).

An electron diffraction camera provided with a rotating sector was designed, constructed and tested. Though it has no specially original feature, it is simpler compared with that used in the United States and can be constructed at a little expense. A preliminary result was obtained with polystyrene films and was analysed after the method developed by J. Karle and his co-workers. It showed that this equipment was quite satisfactory in its functions. A.

GEOPHYSICS 55

550.312

2089. Some notes concerning the question of isostasy. L. Egyed. *Acta tech. Hungar.*, **4**, *No.* 1–4, 75–82 (1952).

Discusses an isostatic model in which the earth's crust is taken to have two layers and allowance is made for the increase of density of clay sediments with depth. A. H. COOK

550.341

2090. Note on Love waves in a homogenous crust laid upon heterogenous medium. S. C. Das Gupta. Letter in *J. appl. Phys.*, **23**, 1276–7 (*Nov.*, 1952).

The density and rigidity of the lower layer are assumed to be given by:

$$\text{I}\quad \rho = \rho' e^{pz},\ \mu = \mu' e^{pz},\ p < 0$$
$$\text{II}\quad \rho = \rho'(1 + z/\lambda),\ \mu = \mu'(1 + z/\lambda)^2$$

Love waves with velocity c can exist if $\mu'/\rho' > c^2 > \mu/\rho$. A. H. COOK

550.341

2091. Seismic refraction experiments in the Pacific. T. F. Gaskell and J. C. Swallow. *Nature* [*London*] **170**, 1010–12 (*Dec.* 13, 1952).

See also Abstr. 6606 (1951).

550.341 : 621.317.79

2092. Portable seismograph. H. J. Whitehill, Jr. *Radio-Electronic Engng*, **1952**, 6, 29 (*Dec.*).

The instrument is designed primarily for detecting that explosive charges at the bottom of oil wells have actually detonated but may be used to assist in gun aiming by measuring shock transit times, and for detecting any ambient or ground noise. The unit is battery-operated and completely enclosed in a water-tight aluminium cylinder with the crystal pick-up, using a lever-arm-weighted armature, connected to a spike for insertion in the ground. A 4-stage amplifier, limited above 2 kc/s, feeds a 0·1 sec time-constant circuit and indicating meter. A relay also in the output circuit may be used to operate alarm devices. E. D. HART (R)

550.93 : 539.155.2

2093. Variations in the relative abundances of the isotopes of common lead. C. B. Collins, R. M. Farquhar and R. D. Russell. *Phys. Rev.*, **88**, 1275–6 (*Dec.* 15, 1952).

Mass spectrometer measurements of the relative isotopic abundances of samples of Pb ores from Archean-type rocks showed larger variations than reported by Nier. The isotopic constitution of one Pb was within the limits calculated by Holmes and by Bullard and Stanley. From the new measurements combined with existing data estimates of the time of formation of the earth's crust of 3·5 billion years and of a maximum time of formation of the elements of 5·5 billion years have been calculated. These values are in reasonable agreement with previous estimates. A.

ATMOSPHERE . METEOROLOGY 551.5

551.501.8

2094. Application of radar to meteorology. R. F. Jones. *Nature* [*London*] **170**, 1004–5 (*Dec.* 13, 1952).

Summary of third Radar Weather Conference held in Montreal in Sept. 1952. Topics dealt with are: precipitation mechanisms, cloud observations and cloud radar problems, possibilities of using airborne radar to increase passenger safety and comfort, rain measurements, instruments, atmospheric scattering and fluctuating signals. G. M. BROWN

551.510.534

2095. Sharpness of the ozone layer optical upper limit. U. Stille. *Abhandl. Braunschw. Wiss. Gesell.*, **4**, 48–57 (1952) *In German.*

A difference Δx of the heights in the atmosphere of the earth is considered as a measure of the "sharpness" of the optical upper limit of the ozone layer which strongly absorbs ultraviolet sunlight in the spectral region of the Hartley band. This difference Δx is defined by the condition that an ultraviolet sunbeam, traversing the atmosphere at height x with intensity $I_0(\lambda)$, will be weakened to an intensity $I(\lambda) = 10^{-2}.I_0(\lambda)$ by ozone absorption if the path of the sunbeam through the atmosphere is lowered by the amount Δx. Approximating the real distribution of atmospheric ozone with height by suitable exponential functions, the constants of which are to be taken from the observed distributions, the thickness d of absorption in the ozone layer is evaluated for different basic heights x_0 of the ultraviolet beam. In this way, using different decadic coefficients of absorption, $\alpha(\lambda)$, of the Hartley

band, one gets the corresponding curves of $I(\lambda)/I_0(\lambda)$ against the height h over the ground for the average distributions of atmospheric ozone over Arosa and Tromsø. From a detailed discussion of these curves, it follows that the "sharpness" Δx of the optical upper limit of the atmospheric ozone layer is of the order of 1 to 2 km. The consequences for the decay with time of the intensity of the *D*-lines of sodium, emitted in twilight, are mentioned. A.

551.510.535

2096. A new early-morning ionospheric phenomenon. B. N. Bhargava. Letter in *Nature* [*London*] **170,** 983–4 (*Dec.* 6, 1952).

Observations at Kodaikanal over March–July, 1952, show that on about 60% of the days ionospheric echoes from virtual heights of 200–300 km ceased for some time (minutes to several hours) during the pre-dawn period, and reappeared at about ground sunrise time from markedly greater virtual heights of 300–500 km. On mornings when this "no echo" condition was not observed there still appeared a stratum at 300–600 km almost simultaneously with ground sunrise, which moved rapidly downwards to merge with the overnight *F* layer. G. M. BROWN

551.510.535

2097. A study of winds in the ionosphere by radio methods. J. H. Chapman. *Canad. J. Phys.*, **31,** 120–31 (*Jan.*, 1953).

Winds in the ionosphere have been studied by a method described by S. N. Mitra using the fading of radio echoes at spaced receivers. A mean daily wind variation of nearly semidiurnal period and about 40 m/sec amplitude has been observed at a nominal height of 110 km (region *E*). The wind variation is consistent with the explanation that it is due to tidal oscillations of the atmosphere. A wind variation consistent with that expected from lunar atmospheric tides has also been detected at this level. The winds in the *F* region appear to increase in velocity with an increase of magnetic activity. A similar effect is not observed in the *E* region except during severe ionospheric disturbances. A.

551.510.535 : 538.566.3

Radio wave propagation in the ionosphere. *See Abstr.* 1789–91

551.510.535 : 550.385

2098. Geo-morphology of *F*2-region ionospheric storms. D. F. Martyn. *Nature* [*London*] **171,** 14–16 (*Jan.* 3, 1953).

Assuming the author's hypothesis that ionospheric storms are due, not to direct particle bombardment, but to an electrostatic field spreading from intense current systems set up in auroral zones during magnetic storms, a study of data over 3 years shows that all major *F*2 perturbations, except those associated with the relatively small travelling disturbances of unknown origin, are associated with magnetic storms. The precise effect of a given storm, however, depends markedly on the season and the local time. This refutes the classification of Appleton and Piggott [see Abstr. 4536 (1950)] which was based on noon values only. G. M. BROWN

551.510.535 : 551.594.13

2099. Conductivity of the ionosphere. W. G. Baker and D. F. Martyn. *Nature* [*London*] **170,** 1090–2 (*Dec.* 27, 1952).

The explanation of the observed geomagnetic daily variations in terms of the dynamo theory and tidal oscillations is examined and it is concluded that all the combined regions of the ionosphere appear to have insufficient conductivity, by a factor of at least 10. Re-examination of the fundamental principles involved in the production of electric currents by tidal winds shows that there are additional sources of effective conductivity previously ignored: when the electric field, current and magnetic field are all mutually at right angles (Hall conductivity), and when currents flow parallel to the electric field and transverse to the magnetic field. Allowance for these increases the effective conductivity of the ionosphere by a factor of 12 over most of the earth, and by a factor of 29 near the magnetic equator. This supports the dynamo theory and also appears to account for the anomalously large magnetic variations at the magnetic equator. The current system should lie mainly in the region 100–150 km. G. M. BROWN

551.510.535 : 551.594.13

2100. Dynamo currents and conductivities in the earth's upper atmosphere. S. F. Singer, E. Maple and W. A. Bowen, Jr. *Nature* [*London*] **170,** 1093–4 (*Dec.* 27, 1952).

Rocket measurements near the magnetic equator [Abstr. 8370 (1951)] led to the discovery in the ionospheric *E*-layer of a magnetic discontinuity produced by the Balfour Stewart (dynamo) current which is responsible for the diurnal (S_q) variation of the sea level magnetic field. The altitude interval in which this electric current flows is found to be very restricted; the deduced specific conductivity is ~1000 times the value calculated when taking into account the reduction due to the horizontal magnetic field. To remove this discrepancy it is suggested that a polarization field produced by a transient Hall current offsets the effect of the magnetic field; the resultant increase in the conductivity is sufficient to agree with the value deduced from the rocket measurement. The observed current is then identified with that predicted by Hirono as well as with the "electrojet" current empirically proposed by Chapman to account for the exceptionally high value of S_q at Huancayo. The electrojet may thus be explained purely on the basis of the dynamo theory. AUTHOR

551.594.14

2101. On the abnormal radioactivity of the atmosphere. H. Garrigue. *C.R. Acad. Sci.* [*Paris*] **235,** 1498–9 (*Dec.* 10, 1952) *In French.*

Continuation of previous work in the region of Puy de Dôme [Abstr. 3157 (1952)]. A further 22 aeroplane flights have been made and these have shown the existence of non-local soots and of radioactive particles of periods of both 25 and 100–400 hours. On these occasions it has not been possible to correlate the data with atomic explosions.

J. M. HOUGH

551.594.221 : 538.566.2

On the propagation of very long electric waves and the wave spectrum of the lightning discharge. *See Abstr.* 1787

551.594.51

2102. Enhancement of auroral hydrogen lines towards lower latitudes. L. VEGARD. Letter in *Nature* [*London*] **170,** 1120–1 (*Dec.* 27, 1952).

Based on the author's conception of the solar particle-stream causing geomagnetic disturbance and aurorae it is shown that an increase of proton velocity $> c.$ 10^7 cm sec^{-1} will produce a strengthening of auroral H emission in latitudes lower than that of the auroral zones. This is confirmed from a comparison of spectrograms taken at Tromsoe, and Oslo, the obsd. intensity ratio being 0·15 : 1. D. R. BARBER

551.594.51

2103. Excitation of sunlit aurorae. O. OLDENBERG. *Z. Phys.*, **133,** *No.* 1–2, 15–20 (1952) *In German.*

Spectrograms of sunlit auroral rays show enhanced forbidden O I line at 6300Å, and also blue bands of N_2^+; whereas auroral emissions in the earth-shadow exhibit no enhancement of the blue bands. To explain this, fluorescence, in addition to electronic excitation, is invoked, following the theory of Bates (1949). D. R. BARBER

BIOLOGY 57/59

578.088.5 : 537.531

2104. A device for high-intensity, vacuum-irradiation of small samples at controlled temperatures. C. S. BACHOFER. *Science,* **116,** 354–5 (*Oct.* 3, 1952).

The sample, in an Al cup, is attached by a gasket and machined flange to the beryllium window of an X-ray tube and in line with the target. The chamber formed by the cup and tube can be evacuated or filled with gas, and is surrounded by a small liquid bath which may be heated electrically. The sample temperature is measured by a thermocouple junction in contact with the bottom of the Al cup. The cup and bath container are surrounded by a Dewar flask containing a suitable cooling agent. The device is adapted for rapid transfer of samples and is stated to have been used for dried bacteriophage and enzyme preparations down to −196°C. S. WEINTROUB

591.088.5

2105. The mortal effects of total irradiation in the Zoe pile on mice. The component radiations in the lethal action of total irradiation of mice in the uranium pile. P. BONÉT-MAURY AND A. ERTAUD. *C.R. Acad. Sci.* [*Paris*] **235,** 828–32 (*Oct.* 13); 909–11 (*Oct.* 20, 1952) *In French.*

Mice have received total irradiation by placing their metal cage in the Châtillon pile. The survival curve is given, and compared with that for X- and γ-rays. The biological effect is far greater for a surrounding cage of Cd than for one of Al. The components of the pile radiation are analysed, and a curve shows the equivalent dose in roentgens for the biological effect considered. D. V. MABBS

591.088.5

2106. A new radioactive method for marking mosquitoes. M. B. ARAGÃO, E. FROTA-PESSÔA AND N. MARGEM. *Notas de Fisica, No.* 4, 5 *pp.* (1952).

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.1

2107. A large capacity, all-glass dispersion oxygenator and pump. L. C. CLARK, JR, F. HOOVEN AND F. GOLLAN. *Rev. sci. Instrum.,* **23,** 748–53 (*Dec.,* 1952).

A large capacity all-Pyrex dispersion oxygenator and pump is described which is capable of substituting temporarily for the function of the heart and lungs. Blood is oxygenated by tiny bubbles of oxygen dispersed in the blood. These bubbles are coalesced on a polymethylsiloxane surface and eliminated in a bubble trap which also serves as the pumping chamber. Pumping is accomplished by an alternating suction and pressure controlled by two electrodes, suspended in the chamber, which actuate two solenoid valves. The apparatus causes no significant damage to the red blood cells. The apparatus is portable, easily cleaned and sterilized, and inexpensive. Oxygenation, carbon dioxide elimination, temperature, pulsation rate and pressure, flow, and mean pressure can be controlled for various physiological studies. The blood volume of the apparatus is constant except for the stroke volume and in this respect resembles the normal heart. A.

612.843.31

2108. Effect of illumination in testing color vision with pseudo-isochromatic plates. I. SCHMIDT. *J. Opt. Soc. Amer.,* **42,** 951–5 (*Dec.,* 1952).

The intensity and the spectral energy distribution within ranges found in natural daylight have a certain effect on the interpretation of pseudo-isochromatic plates. A variation of illumination between 270 and 1000 *lx* affects colour defectives; the error percentage on plate tests decreasing slightly with higher illuminations. This decrease is chiefly found in deuteranomalous subjects. The colour temperature of the illumination affects the number of errors made by both normals and colour defectives. As the colour temperature is increased, the error percentage increases slightly in normals, distinctly in deuteranomalous and less noticeably in deuteranopes. Protanomalous and protanopic subjects do not show a significant effect. On the average, the same percentages of errors result when either a Macbeth easel daylight lamp or a fluorescent daylight lamp is used for the illumination of the plates, provided the same intensity is present. It is recommended that only artificial daylight of a standardized colour temperature and intensity be used

to obtain comparable results in pseudo-isochromatic plate tests. A.

612.843.371

2109. Measurement of accommodation in dim light and in darkness by means of the Purkinje images. M. KOOMEN, R. SCOLNIK AND R. TOUSEY. *J. Opt. Soc. Amer.*, **43**, 27–31 (*Jan.*, 1953).

The state of focus of the eye in dim light and in total darkness was investigated by photographing the Purkinje images of a double aperture placed over a high-speed flash lamp. Measurement of the photographed images showed that all subjects, when viewing a dim scene, remained focused for far vision. By subjective test, however, these subjects were myopic under the same conditions of dim light. The experimental results thus favour the theory that "night myopia" is a result of the aberrations of the eye and is not due to accommodation. The flash photographs taken in total darkness showed that three subjects remained focused for far vision; the fourth subject sometimes accommodated, by amounts varying between 0·5 and 1·5 dioptre. A.

612.843.611

2110. Mechanisms in peripheral dark adaptation. M. A. BOUMAN. *J. Opt. Soc. Amer.*, **42**, 941–50 (*Dec.*, 1952).

Measurements are presented of the absolute thresholds for red and green test flashes at various times during a 0·5 sec interruption of a red and green adapting field occurring each 3 sec, under variation of the size d of the test spot between 4′–420′ and the brightness $\bar{n}$ of the adapting field. Peripheral vision 7° nasal from the fovea of the observer's right eye is concerned. From these measurements nervous and photochemical components in adaptation are detected with the aid of speculations on the validity of quanta-explanations for visual functions. The dependence of the absorption power of the photochemical substances on the adapting brightness deduced from the reported data, agree with the steady-state equation in photochemical theories. With increasing brightness of the adapting field for green test flashes, Ricco's region in the curve representing the absolute threshold as a function of d diminishes, whereas the minimal necessary number of quanta that is absorbed in the receptors such that they contribute to the light perception increases. A.

612.843.611

2111. Duration and light-dark ratio of intermittent preadaptation as factors influencing human dark adaptation. E. R. ADAIR. *J. Opt. Soc. Amer.*, **43**, 22–7 (*Jan.*, 1953).

The influence of intermittent preadaptation upon subsequent dark adaptation was investigated for six preadaptation durations ranging from 30 sec to 16 min. The rate of intermittence was 1 c/s and four ratios of light-to-dark (plus continuous light) were used. The preadaptation intensity was 1188 mL. The resulting dark adaptation curves show that an increase in the duration of intermittent preadaptation produces an elevation in initial threshold, a prolonging of dark adaptation and a decrease in the rate at which dark adaptation proceeds. An increase in the light-time of the light-dark ratio will affect dark adaptation in a similar manner. A.

612.843.613

2112. The intensity-time relation for multiple flashes of light in the peripheral retina. E. DAVY. *J. Opt. Soc. Amer.*, **42**, 937–41 (*Dec.*, 1952).

This study investigates the effect upon threshold of multiple light pulses, 0·01 sec in duration, that fall on the peripheral retina. In one series of experiments a train of 1 to 5 such pulses is presented, the interval between pulses being 0·01 sec. The maximum duration of such a train of pulses is shorter than the critical duration for a single flash of light, found by Long to be 0·10 sec, under conditions similar to those that hold in the present investigation. In another series of experiments, threshold determinations are made for two such pulses separated by 4 temporal intervals less than, and by 6 temporal intervals greater than, critical duration. The results indicate that the breaking up of a light stimulus into separate flashes has no effect upon threshold provided these flashes occur within a critical duration. When 2 flashes are separated by temporal intervals greater than critical duration, threshold energy rises and, at a temporal separation of 0·5 sec, is the same for each of two flashes as it is for one flash. Under the latter circumstances the subject reports the existence of two flashes. A.

612.843.621

2113. Studies in physiological optics. II. N. GÜNTHER. *Optik*, **9**, *No.* 11, 523–4 (1952) *In German.*

For Pt I see Abstr. 1305 (1953). The differential equation relating to the visual angle is shown to have geometrical and physiological factors. The latter imposes a limitation on visual space ("physically infinite"); but its radius vector need not be constant and may depend on the state of adaptation of the eye. The equation is generalized to include the least distance of distinct vision. R. A. WEALE

612.843.63

2114. Accuracy and sensitivity of the human eye. M. H. PIRENNE AND E. J. DENTON. *Nature* [*London*] **170**, 1039–42 (*Dec.* 20, 1952).

The mechanism of light absorption in the visual receptors is reviewed, and a semi-quantitative explanation is given of the peculiar inflection obtained when log (visual acuity) is plotted against log (stimulus intensity). It is postulated that the retina is organized into functional units, the really larger having a low threshold and vice versa. The adaptation of the eye to higher intensity levels is thus characterized by a change in the retinal response mosaic which does not necessitate the breakdown or erection of synaptic barriers. Three figs. and a representative list of modern references are given. R. A. WEALE

612.845.92

2115. A multibeam ophthalmoscope for the study of retinal physiology. S. A. TALBOT AND S. W. KUFFLER. *J. Opt. Soc. Amer.*, **42**, 931–6 (*Dec.*, 1952).

An ophthalmoscope is described for electrophysiological research on the retina. It adds to the usual viewing and illuminating beam two stimulating beams whose patterns may also be viewed and photographed. A large region of the mammalian fundus can be surveyed, the eye being in the centre of a spherical coordinate system. The design provides measured adaptive and stimulating parameters over the photopic range, sufficient to study intensity,

colour, timing and spatial interaction in the retinal mechanisms. Extension to mesopia and scotopia is possible. Associated optically and mechanically are devices for locating, holding and directing the eye and head of anaesthetized cats (or monkeys). The eye holder carries a small micromanipulator to control the direction and feed of microelectrodes. This arrangement provides stable electrical contact with single optic ganglion cells for long periods. The method does not interfere with normal metabolism and optical functioning of the eye. A.

612.85

2116. Contribution to a scientific basis of single channel sound transmission. P. BURKOWITZ. *Funk. u. Ton*, **6**, 561–80 (*Nov.*. 1952) *In German.*

Physiological and psychological considerations of "single-channel" transmission. New conceptions are introduced to explain the author's views: e.g. "hearing values" (*Hörwertungen*) and "noise demands" (*Klangforderungen*), "linear and non-linear psychological hearing distortion," "pseudo-localization." The consequences of broadband development are outlined. A. B. WOOD

614.898

2117. Mode of action of agents giving protection from radiation. P. ALEXANDER AND M. FOX. Letter in *Nature* [*London*] **170**, 1022–3 (*Dec.* 13, 1952).

Measurements of degrading of polymethacrylic acid support the view that HO_2 radicals are the effective agents of radiation, and evidence is given that protection both in chemical and biological reactions is due to capture of these radicals. F. T. FARMER

TECHNICAL MATERIALS 66/67

669

2118. On the rationalization of methods of calculating the correct proportions for the ingredients of the charges of metallurgical furnaces. V. A. DYAKOV, V. S. SIVANOV AND YA. YA. DAUBE. *Latv. PSR Zināt. Akad. Vēstis, No.* 12, 171–84 (1950) *In Russian.*

It is shown, from first principles, that the problem can be reduced to the solution of a system of simultaneous linear algebraic equations, which can be done either by means of the usual determinants or, to reduce the labour, by a graphical method explained in the article in some detail, or, still easier and more quickly, by an electrical calculator which is described only in a general outline. N. S. JAPOLSKY

PHOTOGRAPHY 77

771.53

2119. On the mode of action of densitizers. III–IV. A. HAUTOT AND H. SAUVENIER. *Bull. Soc. Roy. Sci. Liège*, **21**, 180–95 (*April–May*, 1952) *In French.*

For Pt II see Abstr. 7815 (1952).

771.53

2120. On the mode of action of densitizers. V–VI. A. HAUTOT AND H. SAUVENIER. *Bull. Soc. Roy. Sci. Liège*, **21**, 266–80 (*June–July*, 1952) *In French.*

Desensitized emulsions were given constant exposures (time×illumination) over a wide range of time values. For a non-colour-sensitive emulsion the degree of desensitization generally increases with decrease of illumination level for phenosafranine and pinacryptol yellow, whereas for K_2CrO_4 only the superficial image follows this rule. With an orthochromatic emulsion only pinacryptol behaves as before; the others show more complex trends.

H. and D. curves are given for several emulsions after washing, or alternatively desensitized, and later developed by MQ with hypo addition to give the total internal image. Other curves refer to the deep internal image, isolated by a modification of the pre-development treatment with CrO_3, but no consistent behaviour was found for different emulsions or desensitizers. Phenosafranine increases the max. density obtainable in the total internal image, but reduces that in the deep internal image. Pinacryptol produces a reduction in both cases. In general, reduction of illumination at constant exposure decreases the density.

S. T. HENDERSON

771.53

2121. On the mode of action of desensitizers. VII. A. HAUTOT AND L. FALLA. *Bull. Soc. Roy. Sci. Liège*, **21**, 281–300 (*June–July*, 1952) *In French.*

The action of desensitizers in increasing the Herschel effect may be an indirect one, due to the removal of the emulsion sensitivity to red light; or a direct one, by the provision of electron traps for the photoelectrons freed from the image grains by red light. Three emulsions desensitized before exposure, then developed for the superficial image, showed that the red light had reduced density, though the effect disappeared in the solarization region. Desensitization after the first exposure, but before the red light treatment, produced density reduction up to the solarization region and increase beyond, compared with the untreated emulsion. These and other experiments with varied desensitizer concentrations and red light exposures show that the indirect mechanism is the main one up to the solarization region, in which the direct mechanism becomes evident. A detailed theoretical discussion includes reference to the Debot effect (oxidation of an emulsion after exposure).

S. T. HENDERSON

771.534

2122. Photographic sensitivity as a function of exposure time and temperature. M. BILTZ. *J. Opt. Soc. Amer.*, **42**, 898–903 (*Dec.*, 1952).

Reciprocity failure curves in the range between 1 and 256 sec exposure time of three fine-grain experi-

mental emulsions containing 2·4 mole % iodide were determined in the temperature range between +50 and −195°C for radiation of 400 mμ wavelength with surface and internal development. The light absorption of the same emulsions in the temperature range between +25 and −137°C for radiation of 400 mμ wavelength was measured. With internal development, practically no low-intensity reciprocity failure occurs at and below −50°C, while with surface development no failure occurs between −50 and −150°C. In no case was high intensity failure observed in this temperature range. With surface development, an extremely large decrease in sensitivity is observed between −150 and −195°C, together with the appearance of a new type of high intensity reciprocity failure. In the same temperature region, a strongly temperature-dependent fluorescence is observed. It is believed that these two effects are connected, and it appears from sensitometric results that (*a*) the effect of the fluorescence is restricted to the grain surface, and (*b*) the fluorescence increases with the intensity of the exciting light at a rate higher than the first power of intensity. A.

771.534

2123. Connection between the sensitivity of a photographic emulsion to a short-duration illumination and its electron sensitivity. A. L. KARTUZHANSKIĬ. *Zh. eksper. teor. Fiz.*, **22**, *No.* 6, 768–74 (1952) *In Russian.*

Both sensitivities have been compared for a number of emulsions, and a parallelism has been revealed, in agreement with theoretical representation. The results are graphed and tabulated. F. LACHMAN

771.534 : 537.533.8

Spectral sensitivity of photographic emulsions to Cherenkov radiation. *See Abstr.* 1683

773.7

2124. The sensitometry of the positive diazotype process. C. E. HERRICK, JR. *J. Opt. Soc. Amer.*, **42**, 904–10 (*Dec.*, 1952).

Equations relating monochromatic dye density to exposure for positive developing diazotype foils are derived for the case of monochromatic actinic illumination. The influence of maximum dye density and initial diazo actinic density on the general sensitometric behaviour is examined, and the theory is extended to the case of polychromatic dye absorption. Calculated sensitometric functions are shown to be in good agreement with experimental sensitometric data. A.

778.33

2125. Improvement to the melted emulsion technique of autoradiography. L. F. BÉLANGER. Letter in *Nature* [*London*] **170**, 625–6 (*Oct.* 11, 1952).

The emulsion from Kodak "High Contrast Positive" film is now used: it is unstained, and easily removed under a relatively bright light; it does not retain air bubbles and has improved resolution. The emulsion is applied to the specimen at 38°C with a dropper. Details for developing and fixing to produce a minimum of fog are given. Staining and clearing the specimen are described. D. V. MABBS

778.33

2126. Application of fluorescence X-rays to metallurgical microradiography. H. R. SPLETTSTOSSER AND H. E. SEEMANN. *J. appl. Phys.*, **23**, 1217–22 (*Nov.*, 1952).

Fluorescence X-rays may be more useful analytically in metallurgical microradiography than the line emission from a tube target because of the greater homogeneity of the former radiation. Although the intensity of fluorescence is very low, exposure times are not prohibitive for some applications. In the present report, the method and apparatus are described and illustrative examples are shown. A.

778.33 : 539.16.08

Study of radioactive minerals by combined electron-reflection radiography and autoradiography. *See Abstr.* 1859

778.33 : 539.166

2127. Some applications of gamma-radiography techniques. M. FALK. *Atomics* [*London*] **3**, 249–55 (*Oct.*, 1952).

Discusses apparatus for γ-ray radiography, the examination of penstocks and the development of containers for radioactive sources. Some examples of γ-ray radiography are given. J. THEWLIS

778.33 : 539.169

2128. Autoradiography of metal surfaces using a radiochemical method. E. RABINOWICZ. Letter in *Nature* [*London*] **170**, 1029–30 (*Dec.* 13, 1952).

Amyl iodide (I^{131}-substituted) is placed on a clean Cu surface, left for 15 sec and wiped off. About 150 atomic layers of I^{131} remain, probably chemically combined. A mild steel surface retains only 10 layers. An autoradiograph is shown of the friction track produced by a spherical Cu surface sliding on steel which is afterwards treated with I^{131} and exposed for 2 days against non-screen X-ray film. The Cu wear-fragments show up well. Other metals have also been examined and the method is held out as one of convenience and flexibility. D. V. MABBS

778.33 : 539.185

2129. On an autoradiographic technique by neutron irradiation for revealing the boron constituent in boron steels. H. FARAGGI, A. KOHN AND J. DOUMERC. *C.R. Acad. Sci.* [*Paris*] **235**, 714–16 (*Oct.* 6, 1952) *In French.*

Specimens of steel, after suitable heat treatment, are placed in contact with an Ilford C_2 nuclear plate and irradiated by slow neutrons in the atomic pile at Châtillon. Owing to the photographic effect of the α-particles emitted in the $B^{10}(n, \alpha)Li^7$ reaction it is possible to detect fine precipitates of B in steels containing as little as 0·01% B. J. THEWLIS

778.33 : 621.386.1

2130. X-ray shadow microscopy. V. E. COSSLETT AND W. C. NIXON. *Nature* [*London*] **170**, 436–7 (*Sept.* 13, 1952).

Describes the construction and use of a point-focus X-ray tube for micro-radiography. A transmission target, consisting of a thin tungsten foil, is used; and the focal spot is $<1\ \mu$ across, the electron beam being focused by a magnetic lens. The object is placed in contact with the target foil, outside the tube, and the film is a few cm distant to enable magnification to be achieved. An initial magnification of 100 or so is not difficult to obtain and further magnification may be obtained photographically. The

estimated resolution is about 0·5 μ. Exposure times are 1–10 min. J. THEWLIS

778.34

2131. Irradiation and development of nuclear emulsions exposed to a high flux of thermal neutrons accompanied by gamma radiation. H. FARAGGI, A. BONNET AND J. COHEN. *J. Phys. Radium*, **13** (*Suppl. No.* 7–8–9) 105A–111A (*July–Aug.–Sept.*, 1952) *In French.*

The recognition of the tracks due to heavy particles in nuclear emulsions exposed to a high neutron flux is limited by the background density produced by secondary electrons due to γ and neutron interactions in the emulsion. The development conditions are described for which the background density is a minimum and the grain density of the tracks due to heavy particles is sufficiently high for good discrimination. Using these conditions the plates can be exposed to 3×10^{12} neutrons per cm^2 and still give good results. A. C. COATES

778.34 : 539.172.4

Energy loss of highly charged particles produced by fission and by cosmic rays. I. Observations of fission fragments. II. Photometric measurements on fission fragments. *See Abstr.* 1927–8

778.37 : 778.31 : 771.36 : 621.383.6 : 621.389

2132. An electronically operated Kerr cell shutter. K. D. FROOME. *Photogr. J. B.*, **92,** 158–61 (*Sept.–Oct.*, 1952).

The factors governing the design of Kerr cells are briefly discussed. An electronic circuit is given which will drive a Kerr cell requiring 10 kV for its operation. A range of exposure times down to 0·1 μsec is available and sequences of exposures can be made at repetition rates of up to 2 500 000 per sec. This apparatus has been used to take low-power photomicrographs of the development of cathode phenomena in arc discharges. Ways of extending the usefulness of the equipment are mentioned. A.

778.37 : 771.36 : 621.383.6/.8

2133. Electro-optical shutters as applied to the study of electrical discharges. J. M. MEEK AND R. C. TURNOCK. *Photogr. J. B.*, **92,** 161–6 (*Sept.–Oct.*, 1952).

Camera-shutters are required with exposure times of 1 μsec or less. A large optical aperture and a wide spectral transmission are also necessary if accurate reproduction of intensity variations is to be obtained. Three types of electro-optical shutters, involving a Kerr cell, an iconoscope and an image converter respectively, have been investigated. The characteristics and operation of these shutters is described, together with a discussion of their relative advantages and limitations. Photographs of spark discharges at different stages of development have been obtained by all these methods and typical examples are shown. Exposure times of 0·5 μsec have been used but shorter exposures are possible. In the image converter the image can be deflected at a high velocity across the screen by the application of a magnetic field. This enables the system to be used as a "streak" camera, and photographs obtained by this method are shown for the variation of spark channel diameter with time. By a combination of electrical pulses and a magnetic deflection the image converter may also be used as a high-speed cine-camera. A.

778.5

2134. Optical arrangement for the recording of high frequency cinematograph images. L. BULL. *C.R. Acad. Sci.* [*Paris*] **235,** 1210–11 (*Nov.* 17, 1952) *In French.*

The apparatus employs 12 separate light sources and prisms to give 12 images each 25 mm dia. on a film 13 × 18 cm at a repetition rate of 10^6 per second. R. W. FISH

778.6

2135. Contributions on colour development. V. On the behaviour of colour developers towards silver salts without binders. K. MEYER AND W. BRUNE. *Z. wiss. Photogr.*, **47,** *No.* 7–9, 129–36 (1952) *In German.*

The reaction between a diethyl-*p*-phenylenediamine developer containing sulphite and potash, and either ammoniacal $AgNO_3$ or precipitated AgBr, was studied at different concentrations of Ag. At equilibrium for any mixture the molar amounts of sulphite and developer removed were equal. The sulphonic acid produced in the primary reaction between these components was further oxidized by the excess of Ag salt, which was reduced to the extent of about 3 moles per mole of developer in the case of ammoniacal Ag salt, or 8 to 10 moles of AgBr. Cu salts had no catalytic effect. These results contrast with those in which atmospheric O_2 was the oxidizer, but when the developer contained NH_2OH the molar amount of sulphite oxidized was greater than that of developer, as in atmospheric oxidation. S. T. HENDERSON

778.6

2136. Contributions on colour development. VI. On the oxidation of colour developers by silver bromide in an emulsion, in the absence of colour couplers. W. BRUNE. *Z. wiss. Photogr.*, **47,** *No.* 7–9, 137–44 (1952). *In German.*

A comparison was made between the amount of developer oxidized and the Ag salt reduced to Ag, both when precipitated AgBr was used (see preceding abstract), and also when the AgBr was in a positive emulsion. In the latter case, after correction for fog, approximately 2 moles of Ag were produced for each mole of developer oxidized, together with 2·6 moles of KBr. NH_2OH increased the amount of Ag reduced. With precipitated AgBr the amount of Ag varied with the original proportions of the mixture, and again NH_2OH increased the amount of Ag. Possible reactions involved are discussed. S. T. HENDERSON